Spring 2016

Impacts of Water Sources on the Effectiveness of Point-Of-Use Water Treatment

Robert Brophy
University of Akron, rmb82@zips.uakron.edu

Impacts of Water Sources on the Effectiveness of Point-Of-Use Water Treatment

Robert Brophy

Department of Civil Engineering

Honors Research Project

Submitted to

The Honors College

Approved:

Date 4/28/16
Honors Project Sponsor (signed)

CHRISTOPHER MILLER
Honors Project Sponsor (printed)

Date 4/28/2016
Reader (signed)

Stephen Duirk
Reader (printed)

Date 4-28
Reader (signed)

William Schneider
Reader (printed)

Accepted:

Date 4/28/16
Department Head (signed)

Wieslaw Binienda
Department Head (printed)

Date 4/29/16
Honors Faculty Advisor (signed)

Ala R. Abbas
Honors Faculty Advisor (printed)

Date ________
Dean, Honors College

HONORS RESEARCH PROJECT

IMPACTS OF WATER SOURCES ON THE EFFECTIVENESS OF POINT-OF-USE WATER TREATMENT

Submitted by

ROBERT BROPHY

to

DR. CHRISTOPHER MILLER

and

THE UNIVERSITY OF AKRON HONORS COLLEGE

APRIL 2016

Table of Contents

List of Figures

List of Tables

Common Abbreviations

AWWA	American Water Works Association
CAP	Central Arizona Project
CCR	Consumer Confidence Report
DOM	Dissolved Organic Matter
EPA	Environmental Protection Agency
GW	Ground water
IX	Ion Exchange
LORE	Lifetime overall removal efficiency
MEL	Manufacturer's expected lifetime
MLR	Mass load rejection
NA	Not applicable
POU	Point-of-Use
SW	Surface water
TOrCs	Trace organic compounds

1.0 Proposal

1.1 Scenario

Disinfection of drinking water provides a safe, reliable, and clean water supply and has been protecting public health successfully throughout the 20th century. However, factors such as deteriorating infrastructure, introduction of microbial pathogens, or disinfection by-products create problems and reduce the effectiveness of a drinking water treatment plant. Every day the public is drinking known carcinogens that are regulated by the EPA and tested for quarterly by treatment plants. To combat rising costs involved with upgrading source water treatment, point-of-use treatment is a popular option that treats water as it leaves the distribution system, instead of being treated before discharge. Point-of-use treatment includes water pitchers, faucet attachments, and dispensers located in refrigerators. These devices provide potential savings for treatment plants in addition to added protection against drinking water contamination.

1.2 Problem

These point-of-use treatment options are not perfect, and several problems arise with their use. What works for one area may not work for another. Both the differences in water quality and the amount of dissolved organic matter (DOM) drastically change the performance of water filters. DOM's enter the filter and slow down its performance by coating the treatment surfaces. As shown in the article *Point-of-Use Devices for Attenuation of Trace Organic Compounds in Water* written by Anumol et al, a surface water source, as opposed to ground water, will reduce the life of these devices. Surface water naturally has more DOM. Next, there is also a large amount of variability between different brands of filters, with each company using different chemicals and production methods. Even minor errors in the manufacturing of filters will cause changes in the removal of unwanted compounds. Lastly, while a recommended filter lifespan is provided by the manufacturer, not everyone in the general public will follow replacement guidelines, and the practical use of a filter may be exceeded.

1.3 Purpose

The purpose of this project is to take information provided by water treatment plants, along with the research done by Anumol et al, and combine it to determine how water filters will perform at a customer's tap based on the conditions of each city's water. A cost analysis will be performed that will compare cost of ownership across various filter types, along with the feasibility of the City of Akron supplying its customers with these point-of-use devices.

1.4 Approach

This project will model the impact of different water sources on point-of-use filters. Data on dissolved organic matter and disinfection by-products will be collected from water treatment plant reports for groundwater and surface water to extrapolate to local water sources. Potential risk from the Consumer Confidence Report will be assessed, and a solution of either a percent reduction in carcinogens or a certain reachable level will be determined. Surrounding cities will be compared to see what filter applies best to that geographic area. From the research of Anumol et al., that filter data will also be extrapolated and applied to other treatment plants water quality characteristics. These results can then be applied to a water distribution system model and used to determine the effectiveness of different brands of filters at the tap of a customer.

2.0 Background Information

2.1 AWWA Article

In September 2015, the American Water Works Association published a peer-reviewed article called *Point-of-Use Devices for Attenuation of Trace Organic Compounds in Water* by Anumol et al. In this research, three pitcher and two refrigerator point-of-use (POU) devices were evaluated using two different waters in Arizona, a groundwater source from the City of Tucson, and a surface water source from the Colorado River. The measurement of trace organic compounds (TOrCs) was the objective of this research so that the devices with the greatest removal can be recommended.

TOrCs include pharmaceuticals, industrial compounds, and personal care products (Anumol et al. 2015). Due to high energy requirements and expensive processes, advanced treatment to treat water with these compounds is not normally applied (Anumol et al. 2015). Small communities and developing countries can find it difficult to afford proper treatment techniques. Most water is used for industrial and service applications, with only 1% of the potable water produced in the United States used for drinking and cooking (Cortuvo 2003). As expensive as water treatment already is, it is counter-productive to treat so much water when the majority is not even used for consumption. In the future, financial and environmental factors may move water treatment towards two levels of quality: one for potable water use, and a second lower quality for nonpotable applications (Anumol et al. 2015).

The results of filter testing are displayed in Figure 2.1 and in Figure 2.2. Figure 2.1 shows the removal efficiency of TOrCs for all tested filters. Only the GE and Brita filters lasted 150% of the manufacturer's expected lifetime, while the PUR and Whirlpool filters did not make it past 50%. The ZeroWater and GE filters have the highest lifetime overall removal efficiency of all the devices. Figure 2.2 compares the mass load rejection of the devices, which accounts for the different volume of water treated by each filter and is defined as the total mass of contaminants rejected by the filter during its specified lifetime (Anumol et al. 2015). When comparing the three personal water devices, the PUR filter has the highest mass rejection in groundwater, but in surface water, the Brita filter that has the highest mass rejection. For the two refrigerator devices, overall they are more effective in TOrCs removal, treat a greater volume of water, and remove ten times more TOrCs when adjusted using MLR. Overall, all filters were negatively affected by the surface water, as shown in Figure 2.2.

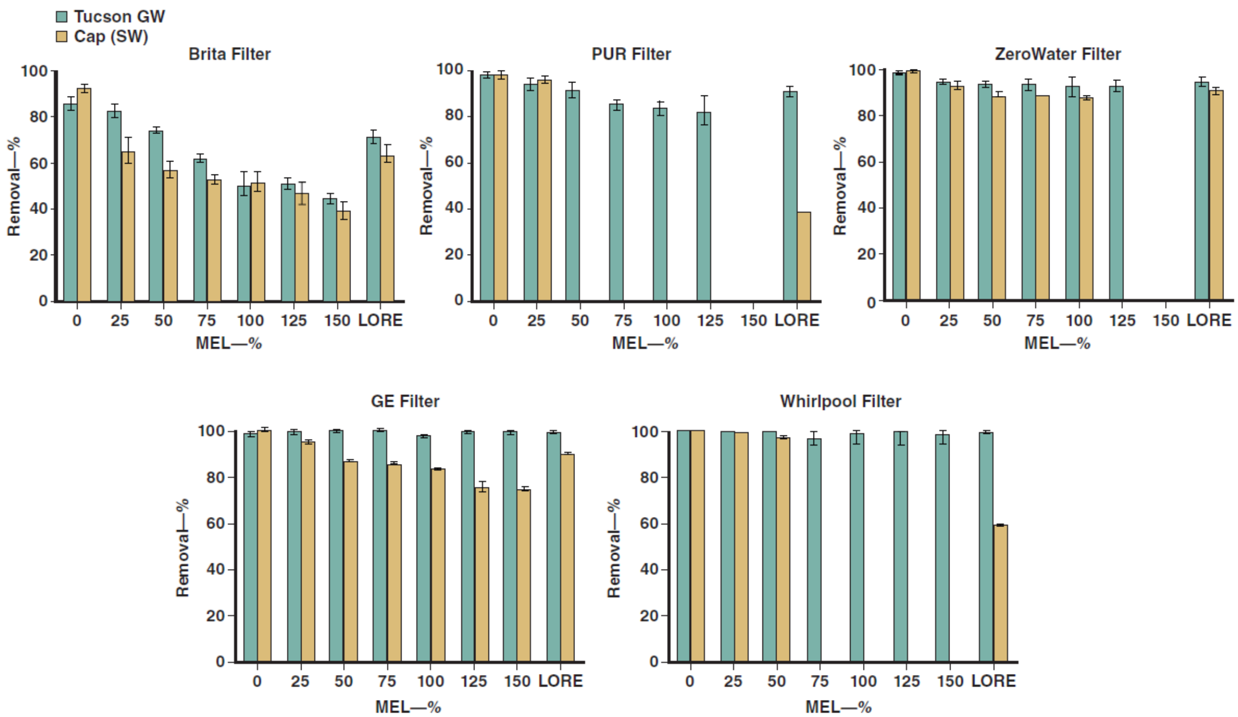


Figure 2.1: Overall removal efficiency of TOrCs by all POU devices for both water types. The groundwater source is on the left of each column pair, with the surface water source on the right. The overall trend for all filters shows that the removal percentage decreases if water treated is from a surface water source. The Whirlpool and PUR filters only made it to 25% and 50% of their expected lifetime with surface water, respectively. In addition, the ZeroWater and GE filters have the highest lifetime overall removal efficiency for both water types. Source: Anumol et al. 2015.

A cost comparison was also completed by this study, and is summarized in Table 2.1. The ZeroWater filter has the highest annual cost at $498 because of its lowered expected lifetime, which requires more frequent replacement of the filter (Anumol et al. 2015). The GE filter has the cheapest cost because of its high filter lifetime. The authors recommend further study into a more thorough cost analysis that accounts for a more detailed life cycle assessment and cost comparisons to bottled water and more advanced treatment technologies (Anumol et al. 2015).

In conclusion, all of these devices reduce TOrCs in potable water, and provide an additional barrier to contamination in a water system. In areas of poor infrastructure and great need of clean drinking water, POU devices can be utilized as an alternative to full-scale treatment (Anumol et al. 2015). However, any benefits that result from the use of these devices relies on the condition that proper maintenance and replacement schedules are followed (Anumol et al. 2015).

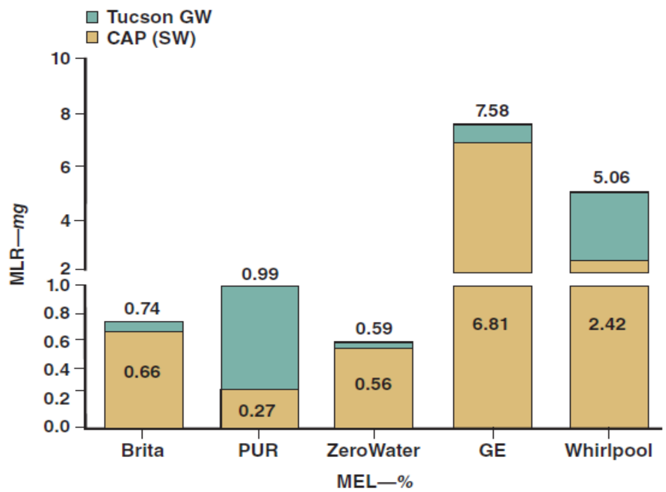


Figure 2.2: Mass load rejection of all tested devices in both water types. Surface water is shown on the bottom, with ground water on top. Mass load rejection accounts for the different volume of water treated by each filter. MLR is the total mass of contaminants rejected by the filter during its lifetime. All filter types were negatively affected by surface water, and no not remove as much TOrCs as compared to groundwater. Source: Anumol et al. 2015.

Table 2.1: Cost comparison of the five POU devices. The ZeroWater filter is the most expensive filter at 0.17 $/L, while the GE refrigerator filter is the cheapest at 0.04 $/L. The cost estimate assumes a full MEL and water usage by a family of four of 2 L/day. Source: Anumol et al. 2015.

Parameter	Brita Riviera	PUR CR-6000	ZeroWater Eight-Cup Filter	GE MSWF	Whirlpool W10295370
Estimated capital cost[a]—*$*	32.99	21.99	33.99	700–3,000	410–2,500
Capacity—*cups*	8	7	8	NA	NA
Replacement filter cost—*$*	7.99	10.99	14.99	41.99	39.99
Filter lifetime—*L*	151	151	85	1136	757
Recommended filter replacement—*months*	2	2	2	6	6
Average filter lifetime[b]—*days*	19	19	11	142	95
Annual cost of ownership[c]—*$*	153	211	498	109	154
Annual cost per liter treated[b]—*$/L*	0.05	0.07	0.17	0.04	0.05

NA—not applicable, POU—point-of-use

[a]Cost of purchasing either the pitcher filter or a compatible refrigerator (data from manufacturer's website)
[b]Assuming a family of four consuming 2 L/d each
[c]Annual cost of ownership does not consider the capital cost of the refrigerator

2.2 Adsorption vs. Ion Exchange in Tested Filters

The faucet POU devices tested consist of several different materials. All of the personal devices contain activated carbon plus ion exchange resin, while the refrigerator units use solid block activated carbon technology and no resin (Anumol et al. 2015). The processes involved in these filters are called adsorption and ion exchange. Adsorption and ion exchange are treatment processes where particles are removed by transferring them to a surface of a solid.

The most common material used in adsorption is activated carbon (Howe et al. 2012). Activated carbon is provided in either granular or powdered form. Adsorption takes place on the surface, so a lot of surface area is required for the process to perform properly. Adsorbents provide a large degree of porosity which allows for this physical necessity. The tighter packed activated carbon in the refrigerator filters as compared to the looser personal use filters means there are more particles and more surface area to filter the water in the larger units. During adsorption, the contaminants are transferred to the activated carbon without any material switching out and returning to the water (Howe et al. 2012). The particles in the water are filtered out through the many pores in the adsorbent.

Ion exchange is similar to activated carbon adsorption but uses a slightly different process where resin is located inside the filter. Ions participate in a two-way transfer between the water and resin, where an ion in the aqueous phase is replaced by one in the solid phase (Howe et al. 2012). Ion exchange resin still has high porosity and a large surface area just like adsorption materials. The resins can further be broken up into cation and anion categories (Howe et al. 2012). Ion exchange is mostly used in small POU devices, which includes the filters tested through the provided research.

3.0 Data Calculation

3.1 Removal Efficiency Diagrams

The article provides removal efficiency as compared to the manufacturer's expected lifetime, as shown in Figure 2.1. The figure graphs both groundwater and surface water for each of the five filter types. Unfortunately, the full quantitative data is not provided in this article. Only the visual representation of each graph and certain specific numbers called out in the text give definite values to the removal efficiency. To find the function of the relationship between removal and life expectancy, the figures need to be graphed in Excel so a trend line can be applied to each one. This requires using all values called out in the article text and making assumptions to fill in the missing pieces. The article gives specific numbers in the text calling out the efficiency at certain lifetime milestones, along with an average value for each filter. In Table 3.1, all of the known values taken directly from the article are shown in black. Since the averages for the MEL from 0-100% were given, it is possible to fill in the missing information, shown in red, and compare the current average with the given one. For example, in the Tucson groundwater for the Brita filter, the red text was filled in until the current average, as shown in blue, matches the LORE that was provided from the article. The figure from the article was used to visually match the relationship between each stage of the MEL. Assumed values in Figure 3.1 fully match the rises and falls as shown in Figure 2.1 taken from the article. The data in Figure 3.1 can be compared to what is shown in the article, and the same relationships can be seen.

Table 3.1: Overall removal efficiency of TOrCs by all POU devices in both water qualities. Red values are interpolated from the AWWA article text and figures to provide a function between the removal percentage and life expectancy.

MEL-%	Brita Filter		PUR Filter		ZeroWater Filter		GE Filter		Whirlpool Filter	
	Tuscon GW	CAP SW	Tuscon GW	CAP SW	Tuscon GW	CAP SW	Tuscon GW	CAP SW	Tuscon GW	CAP SW
0	85.0	91.6	98.0	98.5	98.0	99.6	97.4	99.9	99.7	99.9
25	83.0	64.3	94.9	96.2	95.6	93.7	98.7	97.4	99.6	99.7
50	72.0	57.2	93.3	0	94.1	88.5	99.2	85.3	99.7	97.1
75	63.1	53.1	83.4	0	93.8	88.5	99.6	84.4	96.8	0
100	50.2	51.0	83.6	0	93.2	87.9	96.9	83.3	99.5	0
125	51.0	47.0	82.5	0	93.0	0	98.5	74.5	99.5	0
150	45.5	40.0	0	0	0	0	98.5	74.0	99.0	0
LORE	70.7	63.4	90.6	38.9	94.9	91.6	98.4	90.1	99.2	59.3
AVG	70.7	63.4	90.6	38.9	94.9	91.6	98.4	90.1	99.1	59.3

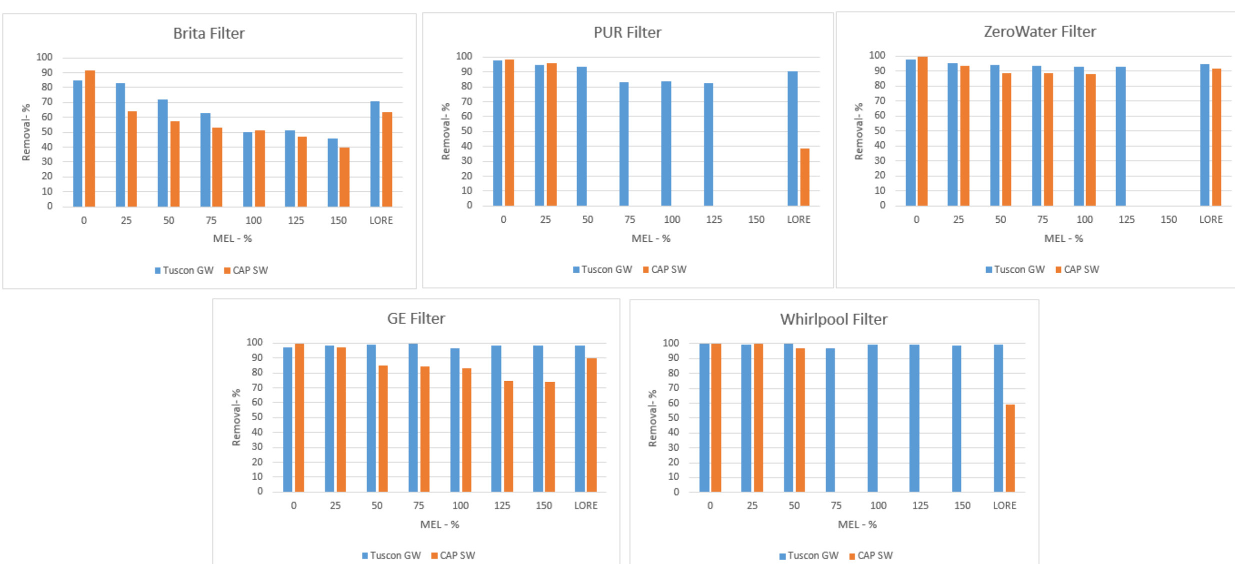


Figure 3.1: Data from Table 3.1 in graphical form. A comparison between groundwater and surface water for each filter type. The surface water decreases in efficiency greater than the groundwater in all cases. Comparative to Figure 2.1.

After fitting the trend lines to the data, as shown in Figure 3.2, Excel provides equations of the lines. All equations use a polynomial function to either the second or third order to accurately fit the provided data. These equations solve for removal percentage if you input MEL. To solve backwards, the Solver program in Excel was used. The program will change the input of the MEL until it reaches a specified removal percentage. For example, as shown in Table 3.2, once the filter reaches 80% efficiency, the table shows how far along in the manufacturer's expected lifetime the filter got. By using the filter lifetime provided by the manufacturer and an assumed water usage of 8 liters per day for a family of four, the maximum number of days a filter can reach can be calculated. Table 3.2 and Figure 3.3 show the results of this calculation. Some filters never drop below 80% to begin with, so those life expectancies go all the way to 100%. Figure 3.2 graphically represents how long each filter will last according to these equations. The PUR and Whirlpool surface water data was not used due to the fact that they both failed at 25% and 50% MEL, respectively.

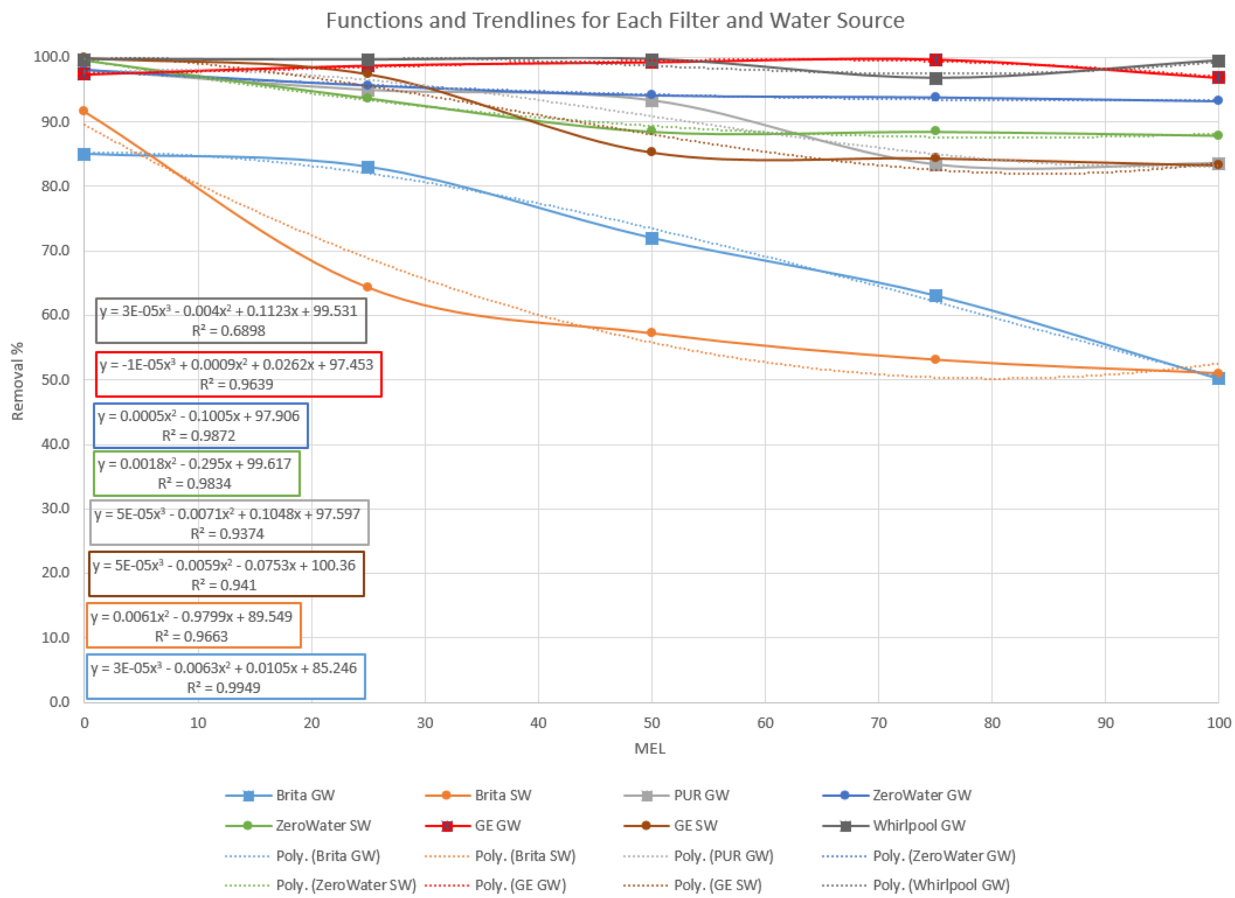


Figure 3.2: Filter data from Table 3.1 plotted with trend lines. The entire rectangular area is the total mass available. Area under each curve is the percentage removed. Dividing the area under the curve by the entire area gives percentage of mass removed.

Table 3.2: Summary of trend line equations and maximum lifetime calculations.

Filter	Water Type	Equation	R^2	Removal %	MEL %	Filter Lifetime (L)	Amount Treated (L)	Usage (L/d)	Theoretical days of usage	Recommended filter replacement (months)	Maximum days of filter usage
Brita	Groundwater	y = 3E-05x3 - 0.0063x2 + 0.0105x + 85.246	0.9949	80	32.38	151	49	10	5	2	5
	Surface water	y = 0.0061x2 - 0.9799x + 89.549	0.9663	80	10.42	151	16	10	2	2	2
PUR	Groundwater	y = 5E-05x3 - 0.0071x2 + 0.1048x + 97.597	0.9374	87	100.00	151	151	10	15	2	15
ZeroWater	Groundwater	y = 0.0005x2 - 0.1005x + 97.906	0.9872	93	100.00	85	85	10	9	2	9
	Surface water	y = 0.0018x2 - 0.295x + 99.617	0.9834	80	69.44	85	59	10	6	2	6
GE	Groundwater	y = -1E-05x3 + 0.0009x2 + 0.0262x + 97.453	0.9639	99	100.00	1136	1136	10	114	6	114
	Surface water	y = 5E-05x3 - 0.0059x2 - 0.0753x + 100.36	0.941	82	84.60	1136	961	10	96	6	96
Whirlpool	Groundwater	y = 3E-05x3 - 0.004x2 + 0.1123x + 99.531	0.6898	101	100.00	757	757	10	76	6	76

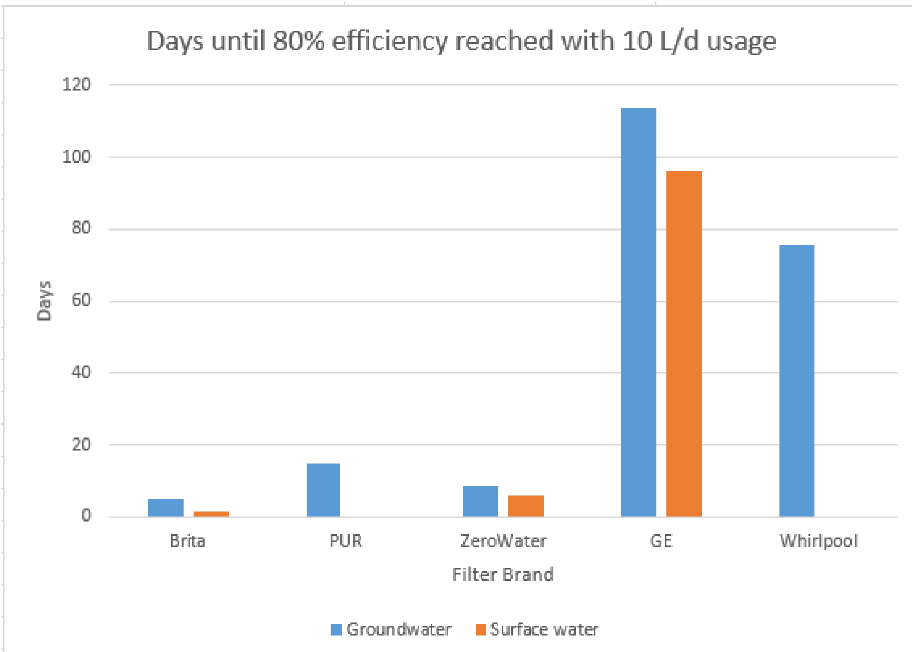


Figure 3.3: Maximum number of days it will take each filter to drop to 80% efficiency based on the manufacturer's suggested lifetime and a usage rate of 10 liters per day.

3.2 Calculating Mass Removed

Through the equations calculated above, it is possible to determine the amount of mass removed over a filter's lifetime. When looking at the curve, as in Figure 3.2, the area under the curve is the cumulative percentage of material removed over the filter's entire lifetime. Therefore, the area above this curve is the amount that passes through the filter and is consumed. Furthermore, the entire rectangle is the total amount that a filter sees prior to treatment. By taking the area under the curve and dividing by the area of the larger rectangle, the percentage of mass removed is calculated. Each equation was plugged into Wolfram Alpha to calculate the definite integral from 0-100% MEL. These numbers were then divided by the total area, found by taking 100 times 100 for a result of 10,000, which gives the percentage of mass removed. A summary of the equations used and calculations performed can be seen in Table 3.3. Furthermore, the percentage of mass removed for each filter is compared in Figure 3.4, which shows a drop in removal for all filters under a surface water condition.

Table 3.3: Percentage of mass removed summary. The Cumulative % Removed column is found by taking the definite integral of the corresponding equation from 0-100% MEL. Overall the surface water source resulted in a lower percentage of mass removed. PUR and Whirlpool data was not used for surface water due to lack of data.

Filter	Water Source	Equation	R²	Total Rectangular Area	Cumulative % Removed	% Mass removed
Brita	Groundwater	y = 3E-05x3 - 0.0063x2 + 0.0105x + 85.246	R² = 0.9949	10000	7277.1	72.77%
	Surface water	y = 0.0061x2 - 0.9799x + 89.549	R² = 0.9663	10000	6088.7	60.89%
PUR	Groundwater	y = 5E-05x3 - 0.0071x2 + 0.1048x + 97.597	R² = 0.9374	10000	9167.0	91.67%
ZeroWater	Groundwater	y = 0.0005x2 - 0.1005x + 97.906	R² = 0.9872	10000	9454.8	94.55%
	Surface water	y = 0.0018x2 - 0.295x + 99.617	R² = 0.9834	10000	9086.7	90.87%
GE	Groundwater	y = -1E-05x3 + 0.0009x2 + 0.0262x + 97.453	R² = 0.9639	10000	9926.3	99.26%
	Surface water	y = 5E-05x3 - 0.0059x2 - 0.0753x + 100.36	R² = 0.941	10000	8942.8	89.43%
Whirlpool	Groundwater	y = 3E-05x3 - 0.004x2 + 0.1123x + 99.531	R² = 0.6898	10000	9931.3	99.31%

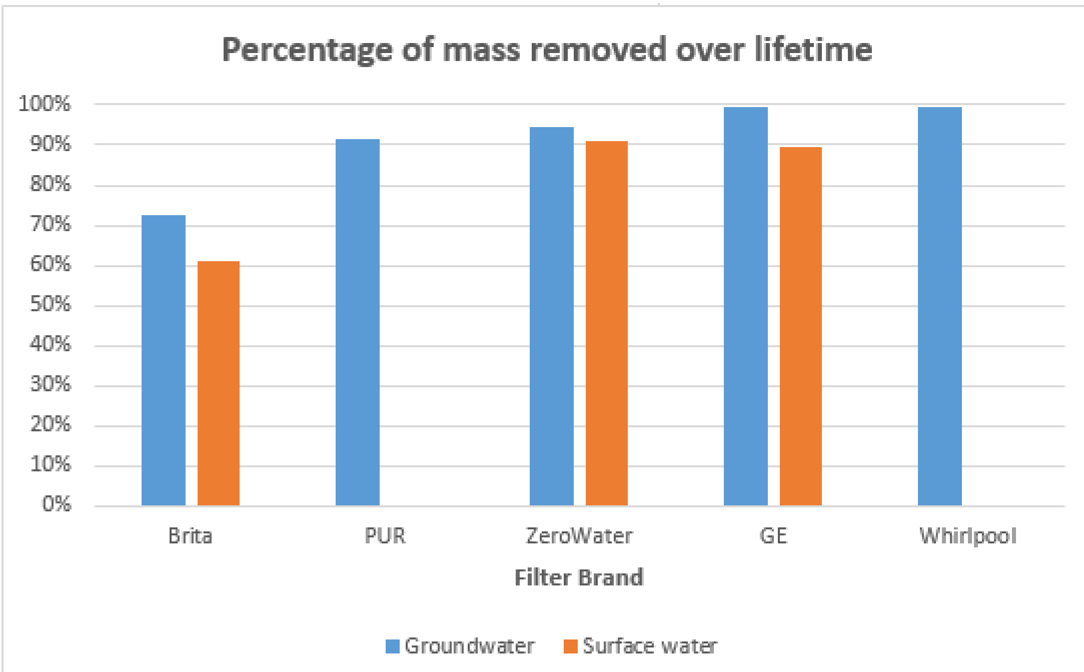


Figure 3.4: The percentage of mass removed over the lifetime of each filter. Between the Brita, ZeroWater, and GE filters, the percentage removed dropped with the surface water source.

By taking an assumed initial TOrC concentration and applying it across all filters, a quantifiable mass removed can be calculated. There were 16 TOrCs tested for in both the surface and ground water, with a range of 140-1,300 ng/L (Anumol et al. 2015). By taking the average of this data, a reasonable total initial concentration to assume for these purposes comes out to be around 12 ug/L. Overall this quantity can be any number because it is being applied to all filters for comparison. By multiplying the lifetime capacity for a filter by the concentration, a total mass applied over the lifetime is found. To see how much of this is removed, the total mass is multiplied by the percentage calculated above. The results show that with an initial concentration of 12 ug/L, the GE filter removed the most at 13.5 mg in ground water and 12.2 mg in surface water. The ZeroWater filter, on the other hand, only removed 0.964 mg in ground water and 0.927 mg in surface water. However, because these filters treat different volumes of water, it is not an apples to apples comparison. By dividing by the filters capacity, both the mass consumed and mass removed per liter treated is determined, showing which filter removed the most per volume. When the capacity is factored in, The ZeroWater filter removes the most at 10.9 ug/L in surface water. In groundwater, the Whirlpool filter removed the most at 11.92 ug/L. All of these results are shown in Table 3.4.

Table 3.4: Total mass calculations. By assuming an initial concentration and multiplying by the removal percentage, a quantitative mass removal can be determined under each water source. Dividing by the filter capacity results in the mass consumed/removed per liter. The green box shows the most effective filter for minimal consumption and maximum removal based on the water source.

Filter	Brita	PUR	ZeroWater	GE	Whirlpool
Lifetime Capacity (L)	151	151	85	1136	757
TOrC Concentration (ug/L)	12	12	12	12	12
Total Mass (mg)	1.81	1.81	1.02	13.63	9.08
Surface Water					
% Mass Removed	60.89%	NA	90.87%	89.43%	NA
Mass removed (mg)	1.103	NA	0.927	12.191	NA
Mass consumed (mg)	0.709	NA	0.093	1.441	NA
Ground Water					
% Mass Removed	72.77%	91.67%	94.55%	99.26%	99.31%
Mass removed (mg)	1.319	1.661	0.964	13.532	9.022
Mass consumed (mg)	0.493	0.151	0.056	0.100	0.062
Mass consumed per liter treated (ug/L)					
Surface Water	4.69	NA	1.10	1.27	NA
Ground Water	3.27	1.0	0.65	0.088	0.082
Mass removed per liter treated (ug/L)					
Surface Water	7.31	NA	10.90	10.73	NA
Ground Water	8.73	11.00	11.35	11.91	11.92

3.3 Normalizing Removal Percentage for Volume

The graphs in Figure 3.1 and 3.2 show removal as a function of MEL. This value is not intuitive and changing the x-axis to volume would make for better comparisons. In addition, changing the x-axis to volume and comparing the resulting removal percentage is a way to check if the numbers in Table 3.3 are accurate. Since the MEL is in a percentage, all that needs done to change this to volume is to multiply each point by that filters capacity. For example, At an MEL of 25%, 50%, 75%, and 100%, the Brita filters volume would be 37.75, 75.5, 113.25, and 151 L, respectively. Table 3.5 shows the adjusted volume and removal percentages that are then plotted in Figure 3.5. The shape of the resulting graphs resemble those in Figure 3.2, and when a trend line is shown, the constant and r-squared values are identical. These graphs in Figure 3.5 now have larger rectangular areas for the total mass approaching the filter, but also have a larger area under the curve. The same process as used earlier provides the area under the curve, and through division the percentage of mass removal is calculated. The results match those values calculated in Table 3.3, showing that using either the MEL or volume along the x-axis will certainly provide the percentage of mass removal over the lifetime of a filter. Only the GE, ZeroWater, and Brita filters were compared here because they all had data for both ground and surface water. Table 3.6 summarizes the equations and percentage of mass removed values found in this process.

Table 3.5: Removal percentage values similar to Table 3.1, with the x-axis changed to volume.

Volume (L):	**0**	**37.75**	**75.5**	**113.25**	**151**
Brita GW	85.0	83.0	72.0	63.1	50.2
Brita SW	91.6	64.3	57.2	53.1	51.0
Volume (L):	**0**	**21.25**	**42.5**	**63.75**	**85**
ZeroWater GW	98.0	95.6	94.1	93.8	93.2
ZeroWater SW	99.6	93.7	88.5	88.5	87.9
Volume (L):	**0**	**284**	**568**	**852**	**1136**
GE GW	97.4	98.7	99.2	99.6	96.9
GE SW	99.9	97.4	85.3	84.4	83.3

Table 3.6: Trendline equations as a result of plotting volume instead of MEL. The total approaching the filter is higher, as compared to Table 3.3, but so is the integrated area. While the coefficients are different, the constant and r-squared values are identical to the trend line equations above. The resulting percentage mass removed values equal those calculated earlier.

	Brita	
	Groundwater	**Surfacewater**
Equation	y = 8E-06x3 - 0.0027x2 + 0.0069x + 85.246	y = 0.0027x2 - 0.6489x + 89.549
R^2	R^2 = 0.9949	R^2 = 0.9663
Total cumulative % available to be removed (rectangle area)	15100	15100
% Removed (Integral of function over MEL)	10891.9	9222.8
% Mass removed	72.1%	61.1%
	ZeroWater	
	Groundwater	**Surfacewater**
Equation	y = 0.0008x2 - 0.1182x + 97.906	y = 0.0025x2 - 0.347x + 99.617
R^2	R^2 = 0.9872	R^2 = 0.9834
Total cumulative % available to be removed (rectangle area)	8500	8500
% Removed (Integral of function over MEL)	8058.8	7725.7
% Mass removed	94.8%	90.9%
	GE	
	Groundwater	**Surfacewater**
Equation	y = -8E-09x3 + 7E-06x2 + 0.0023x + 97.453	y = 3E-08x3 - 5E-05x2 - 0.0066x + 100.36
R^2	R^2 = 0.9639	R^2 = 0.9410
Total cumulative % available to be removed (rectangle area)	113600	113600
% Removed (Integral of function over MEL)	112281.0	97807.3
% Mass removed	98.8%	86.1%

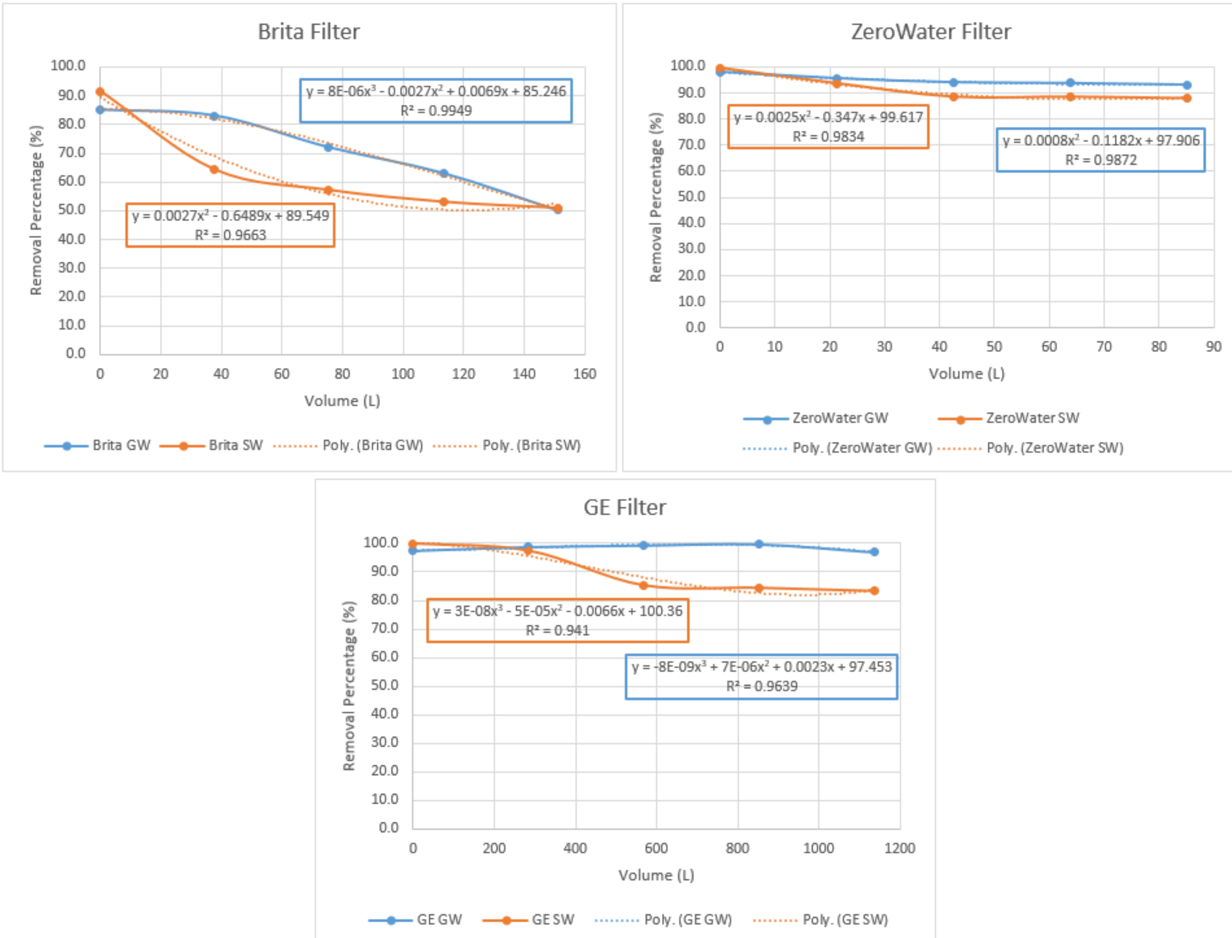


Figure 3.5: Removal percentage graph when the x-axis is normalized to volume. The shapes and equations are similar to those when the MEL is plotted. The resulting removal percentage is exactly the same as those found earlier using the MEL.

Furthermore, by using those functions in Excel, it is possible to input a volume and get a percentage removed at that point. Knowing the capacity of each filter, the percentage of the filter used up to that point can also be found. Plotting these points results in a curve that is expected based on all the relationships found above. The raw data from these calculations can be found in Appendix A.

3.4 Cost Comparison

As seen in Table 2.1, a simple cost comparison was completed using the manufacturer's expected capacity, filter lifetime, and the estimated capital cost. They then determined an annual cost of ownership, with the GE filter being the least expensive at $109 per year, and the ZeroWater filter being the most expensive at $498 per year. This results in a cost per liter of $0.04 and $0.17, respectively. While the ZeroWater looks extremely expensive, the calculations above put it at the most effective removal option for surface water conditions. The cost comparison in Table 2.1 does not account for performance.

The major divide between filters comes when the source is ground or surface water. The efficiency changes, and the mass removed varies depending on the source. For the three filters with sufficient data, the surface water performed better up until a certain point, as shown in Figure 3.5. For the ZeroWater filter, for example, under ground water conditions there will be an exposure of 0.65 ug/L. This corresponds to a removal percentage of 94.55%. Under surface water conditions the performance is worse overall, but in surface water the filter performs better, starting at 99.62%, then dropping below 94.55% when the filter hits 17 L, as seen in Appendix A. In other words, if you look at a filter exposure in groundwater, consumption will be 0.65 ug/L over the filter lifetime. In surface water, the exposure will be less than this until the filter hits 17 L, then exposure will be higher than if the source was ground water. At 17 L, the usage only reaches 20% capacity. To keep the exposure the same across water sources, you need to replace the filter that has surface water every 17 L to match the removal of the filter in ground water. The same thing can be performed for the Brita and GE filters. For Brita, the consumption in ground water is 3.27 ug/L, with a removal of 72.77%. Under the same conditions in surface water, using Appendix A, the exposure will match ground water at 30 L, when the filter drops to 72.51%. This is 20% of the expected lifetime. For the GE filter, the ground water exposure is 0.088 ug/L, with a removal of 99.26%. In surface water, the removal drops to 99.25% at 99 L. This is only 9% of the capacity of the GE filter.

Where one filter in ground water will give a certain exposure, it requires multiple filters to match that exposure in surface water. First, replacing the ZeroWater filter every 17 L requires five filters in surface water for every one filter in ground water. Second, replacing the Brita filter every 30 L requires five filters in surface water for every one filter in ground water. Finally, replacing the GE filter every 99 L requires 12 filters for every one filter in ground water. The cost for these filters to maintain the same exposure in surface water conditions as compared to ground water conditions is calculated in Table 3.7.

Table 3.7: Cost to maintain ground water exposure rate in surface water. With an initial concentration of 12 ug/L, in ground water the filters remove a certain percentage. All filters perform better initially in surface water, and where the surface water removal drops below the ground water removal, using Appendix A, is the limiting volume. A filter will only be able to run this long in surface water to maintain the same exposure rate as groundwater.

Filter	Brita	ZeroWater	GE
TOrC Concentration (ug/L)	12	12	12
GW Exposure (ug/L)	3.27	0.65	0.088
GW Removal Percentage	72.77%	94.55%	99.26%
Limiting Volume in SW (L)	30	17	99
Capacity (L)	151	85	1136
SW Replacements (# Filters)	5	5	12
Cost per filter	$ 7.99	$ 14.99	$ 41.99
Total Cost	$40.22	$ 74.95	$503.88

References

Anumol et al. (2015). "Point-of-Use Devices for Attenuation of Trace Organic Compounds in Water." *Journal AWWA*, 107(9), E474–E485.

Cortuvo, J.A. (2003). "Nontraditional Approaches for Providing Potable Water in Small Systems: Part 1." *Journal AWWA*, 95(3), 69-76.

Howe, K. J., Crittenden, J. C., Howe, K. J., Hand, D. W., Tchobanoglous, G., and Trussell, R. R. (2012). "Principles of Water Treatment." John Wiley & Sons, Inc., Hoboken, NJ. 369-406.

Appendix A

Brita GW: Capacity 151L

Volume	% Removed	Capacity Used
0	85.25	0%
1	85.25	1%
2	85.25	1%
3	85.24	2%
4	85.23	3%
5	85.21	3%
6	85.19	4%
7	85.16	5%
8	85.13	5%
9	85.10	6%
10	85.05	7%
11	85.01	7%
12	84.95	8%
13	84.90	9%
14	84.84	9%
15	84.77	10%
16	84.70	11%
17	84.62	11%
18	84.54	12%
19	84.46	13%
20	84.37	13%
21	84.27	14%
22	84.18	15%
23	84.07	15%
24	83.97	16%
25	83.86	17%
26	83.74	17%
27	83.62	18%
28	83.50	19%
29	83.37	19%
30	83.24	20%
31	83.10	21%
32	82.96	21%
33	82.82	22%
34	82.67	23%
35	82.52	23%
36	82.37	24%
37	82.21	25%
38	82.05	25%
39	81.88	26%
40	81.71	26%
41	81.54	27%
42	81.37	28%
43	81.19	28%
44	81.00	29%
45	80.82	30%
46	80.63	30%
47	80.44	31%
48	80.24	32%
49	80.04	32%
50	79.84	33%
51	79.64	34%
52	79.43	34%
53	79.22	35%
54	79.01	36%
55	78.79	36%
56	78.57	37%
57	78.35	38%
58	78.12	38%
59	77.90	39%
60	77.67	40%
61	77.44	40%
62	77.20	41%
63	76.96	42%
64	76.73	42%
65	76.48	43%
66	76.24	44%
67	75.99	44%
68	75.75	45%
69	75.50	46%
70	75.24	46%
71	74.99	47%
72	74.73	48%
73	74.47	48%
74	74.21	49%
75	73.95	50%
76	73.69	50%
77	73.42	51%
78	73.15	52%
79	72.88	52%
80	72.61	53%
81	72.34	54%
82	72.07	54%
83	71.79	55%
84	71.52	56%
85	71.24	56%
86	70.96	57%
87	70.68	58%
88	70.40	58%
89	70.11	59%
90	69.83	60%
91	69.54	60%
92	69.26	61%
93	68.97	62%
94	68.68	62%
95	68.39	63%
96	68.10	64%
97	67.81	64%
98	67.52	65%
99	67.23	66%
100	66.94	66%
101	66.64	67%
102	66.35	68%
103	66.05	68%
104	65.76	69%
105	65.46	70%
106	65.17	70%
107	64.87	71%
108	64.58	72%
109	64.28	72%
110	63.98	73%
111	63.69	74%
112	63.39	74%
113	63.09	75%
114	62.80	75%
115	62.50	76%
116	62.20	77%
117	61.91	77%
118	61.61	78%
119	61.31	79%
120	61.02	79%
121	60.72	80%
122	60.43	81%
123	60.13	81%

Brita SW: Capacity 151L

Volume	% Removed	Capacity Used
0	89.55	0%
1	88.90	1%
2	88.26	1%
3	87.63	2%
4	87.00	3%
5	86.37	3%
6	85.75	4%
7	85.14	5%
8	84.53	5%
9	83.93	6%
10	83.33	7%
11	82.74	7%
12	82.15	8%
13	81.57	9%
14	80.99	9%
15	80.42	10%
16	79.86	11%
17	79.30	11%
18	78.74	12%
19	78.19	13%
20	77.65	13%
21	77.11	14%
22	76.58	15%
23	76.05	15%
24	75.53	16%
25	75.01	17%
26	74.50	17%
27	74.00	18%
28	73.50	19%
29	73.00	19%
30	72.51	20%
31	72.03	21%
32	71.55	21%
33	71.08	22%
34	70.61	23%
35	70.15	23%
36	69.69	24%
37	69.24	25%
38	68.79	25%
39	68.35	26%
40	67.91	26%
41	67.48	27%
42	67.06	28%
43	66.64	28%
44	66.22	29%
45	65.82	30%
46	65.41	30%
47	65.02	31%
48	64.62	32%
49	64.24	32%
50	63.85	33%
51	63.48	34%
52	63.11	34%
53	62.74	35%
54	62.38	36%
55	62.03	36%
56	61.68	37%
57	61.33	38%
58	61.00	38%
59	60.66	39%
60	60.34	40%
61	60.01	40%
62	59.70	41%
63	59.38	42%
64	59.08	42%
65	58.78	43%
66	58.48	44%
67	58.19	44%
68	57.91	45%
69	57.63	46%
70	57.36	46%
71	57.09	47%
72	56.83	48%
73	56.57	48%
74	56.32	49%
75	56.07	50%
76	55.83	50%
77	55.59	51%
78	55.36	52%
79	55.14	52%
80	54.92	53%
81	54.70	54%
82	54.49	54%
83	54.29	55%
84	54.09	56%
85	53.90	56%
86	53.71	57%
87	53.53	58%
88	53.35	58%
89	53.18	59%
90	53.02	60%
91	52.86	60%
92	52.70	61%
93	52.55	62%
94	52.41	62%
95	52.27	63%
96	52.14	64%
97	52.01	64%
98	51.89	65%
99	51.77	66%
100	51.66	66%
101	51.55	67%
102	51.45	68%
103	51.36	68%
104	51.27	69%
105	51.18	70%
106	51.10	70%
107	51.03	71%
108	50.96	72%
109	50.90	72%
110	50.84	73%
111	50.79	74%
112	50.74	74%
113	50.70	75%
114	50.66	75%
115	50.63	76%
116	50.61	77%
117	50.59	77%
118	50.57	78%
119	50.56	79%
120	50.56	79%
121	50.56	80%
122	50.57	81%
123	50.58	81%

ZeroWater GW: Capacity 85L

Volume	% Removed	Capacity Used
0	97.91	0%
1	97.79	1%
2	97.67	2%
3	97.56	4%
4	97.45	5%
5	97.34	6%
6	97.23	7%
7	97.12	8%
8	97.01	9%
9	96.91	11%
10	96.80	12%
11	96.70	13%
12	96.60	14%
13	96.50	15%
14	96.41	16%
15	96.31	18%
16	96.22	19%
17	96.13	20%
18	96.04	21%
19	95.95	22%
20	95.86	24%
21	95.78	25%
22	95.69	26%
23	95.61	27%
24	95.53	28%
25	95.45	29%
26	95.37	31%
27	95.30	32%
28	95.22	33%
29	95.15	34%
30	95.08	35%
31	95.01	36%
32	94.94	38%
33	94.88	39%
34	94.81	40%
35	94.75	41%
36	94.69	42%
37	94.63	44%
38	94.57	45%
39	94.51	46%
40	94.46	47%
41	94.40	48%
42	94.35	49%
43	94.30	51%
44	94.25	52%
45	94.21	53%
46	94.16	54%
47	94.12	55%
48	94.08	56%
49	94.04	58%
50	94.00	59%
51	93.96	60%
52	93.92	61%
53	93.89	62%
54	93.86	64%
55	93.83	65%
56	93.80	66%
57	93.77	67%
58	93.74	68%
59	93.72	69%
60	93.69	71%
61	93.67	72%
62	93.65	73%
63	93.63	74%
64	93.62	75%
65	93.60	76%
66	93.59	78%
67	93.58	79%
68	93.57	80%
69	93.56	81%
70	93.55	82%
71	93.55	84%
72	93.54	85%
73	93.54	86%
74	93.54	87%
75	93.54	88%
76	93.54	89%
77	93.55	91%
78	93.55	92%
79	93.56	93%
80	93.57	94%
81	93.58	95%
82	93.59	96%
83	93.61	98%
84	93.62	99%
85	93.64	100%

ZeroWater GW: Capacity 85L

Volume	% Removed	Capacity Used
0	99.62	0%
1	99.27	1%
2	98.93	2%
3	98.60	4%
4	98.27	5%
5	97.94	6%
6	97.63	7%
7	97.31	8%
8	97.00	9%
9	96.70	11%
10	96.40	12%
11	96.10	13%
12	95.81	14%
13	95.53	15%
14	95.25	16%
15	94.97	18%
16	94.71	19%
17	94.44	20%
18	94.18	21%
19	93.93	22%
20	93.68	24%
21	93.43	25%
22	93.19	26%
23	92.96	27%
24	92.73	28%
25	92.50	29%
26	92.29	31%
27	92.07	32%
28	91.86	33%
29	91.66	34%
30	91.46	35%
31	91.26	36%
32	91.07	38%
33	90.89	39%
34	90.71	40%
35	90.53	41%
36	90.37	42%
37	90.20	44%
38	90.04	45%
39	89.89	46%
40	89.74	47%
41	89.59	48%
42	89.45	49%
43	89.32	51%
44	89.19	52%
45	89.06	53%
46	88.95	54%
47	88.83	55%
48	88.72	56%
49	88.62	58%
50	88.52	59%
51	88.42	60%
52	88.33	61%
53	88.25	62%
54	88.17	64%
55	88.09	65%
56	88.03	66%
57	87.96	67%
58	87.90	68%
59	87.85	69%
60	87.80	71%
61	87.75	72%
62	87.71	73%
63	87.68	74%
64	87.65	75%
65	87.62	76%
66	87.61	78%
67	87.59	79%
68	87.58	80%
69	87.58	81%
70	87.58	82%
71	87.58	84%
72	87.59	85%
73	87.61	86%
74	87.63	87%
75	87.65	88%
76	87.69	89%
77	87.72	91%
78	87.76	92%
79	87.81	93%
80	87.86	94%
81	87.91	95%
82	87.97	96%
83	88.04	98%
84	88.11	99%
85	88.18	100%

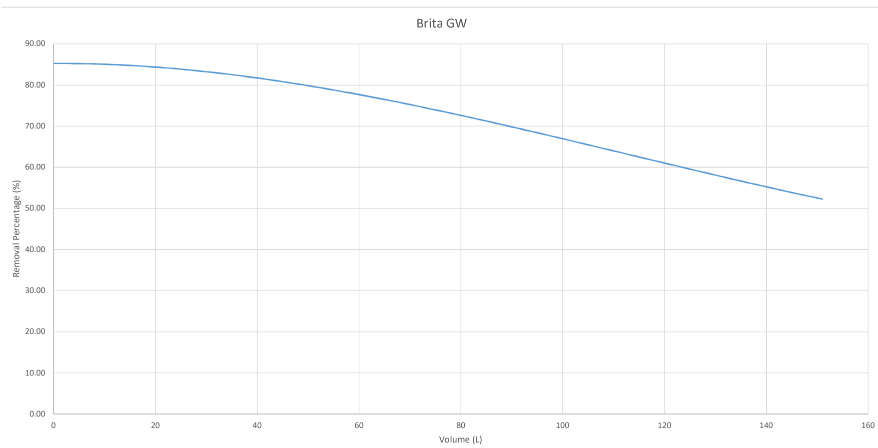
GE GW: Capacity 1136L

Volume	% Removed	Capacity Used
0	97.45	0%
1	97.46	0%
2	97.46	0%
3	97.46	0%
4	97.46	0%
5	97.46	0%
6	97.47	1%
7	97.47	1%
8	97.47	1%
9	97.47	1%
10	97.48	1%
11	97.48	1%
12	97.48	1%
13	97.48	1%
14	97.49	1%
15	97.49	1%
16	97.49	1%
17	97.49	1%
18	97.50	2%
19	97.50	2%
20	97.50	2%
21	97.50	2%
22	97.51	2%
23	97.51	2%
24	97.51	2%
25	97.51	2%
26	97.52	2%
27	97.52	2%
28	97.52	2%
29	97.53	3%
30	97.53	3%
31	97.53	3%
32	97.53	3%
33	97.54	3%
34	97.54	3%
35	97.54	3%
36	97.54	3%
37	97.55	3%
38	97.55	3%
39	97.55	3%
40	97.56	4%
41	97.56	4%
42	97.56	4%
43	97.56	4%
44	97.57	4%
45	97.57	4%
46	97.57	4%
47	97.58	4%
48	97.58	4%
49	97.58	4%
50	97.58	4%
51	97.59	4%
52	97.59	5%
53	97.59	5%
54	97.60	5%
55	97.60	5%
56	97.60	5%
57	97.61	5%
58	97.61	5%
59	97.61	5%
60	97.61	5%
61	97.62	5%
62	97.62	5%
63	97.62	6%
64	97.63	6%
65	97.63	6%
66	97.63	6%
67	97.64	6%
68	97.64	6%
69	97.64	6%
70	97.65	6%
71	97.65	6%
72	97.65	6%
73	97.66	6%
74	97.66	7%
75	97.66	7%
76	97.66	7%
77	97.67	7%
78	97.67	7%
79	97.67	7%
80	97.68	7%
81	97.68	7%
82	97.68	7%
83	97.69	7%
84	97.69	7%
85	97.69	7%
86	97.70	8%
87	97.70	8%
88	97.70	8%
89	97.71	8%
90	97.71	8%
91	97.71	8%
92	97.72	8%
93	97.72	8%
94	97.72	8%
95	97.73	8%
96	97.73	8%
97	97.73	9%
98	97.74	9%
99	97.74	9%
100	97.75	9%
101	97.75	9%
102	97.75	9%
103	97.76	9%
104	97.76	9%
105	97.76	9%
106	97.77	9%
107	97.77	9%
108	97.77	10%
109	97.78	10%
110	97.78	10%
111	97.78	10%
112	97.79	10%
113	97.79	10%
114	97.79	10%
115	97.80	10%
116	97.80	10%
117	97.81	10%
118	97.81	10%
119	97.81	10%
120	97.82	11%
121	97.82	11%
122	97.82	11%
123	97.83	11%

GE SW: Capacity 1136L

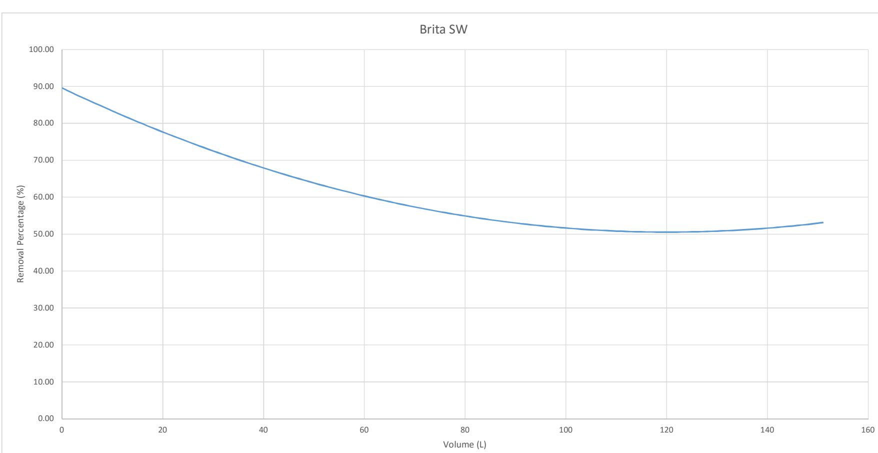
Volume	% Removed	Capacity Used
0	100.36	0%
1	100.35	0%
2	100.35	0%
3	100.34	0%
4	100.33	0%
5	100.33	0%
6	100.32	1%
7	100.31	1%
8	100.30	1%
9	100.30	1%
10	100.29	1%
11	100.28	1%
12	100.27	1%
13	100.27	1%
14	100.26	1%
15	100.25	1%
16	100.24	1%
17	100.23	1%
18	100.23	2%
19	100.22	2%
20	100.21	2%
21	100.20	2%
22	100.19	2%
23	100.18	2%
24	100.17	2%
25	100.16	2%
26	100.16	2%
27	100.15	2%
28	100.14	2%
29	100.13	3%
30	100.12	3%
31	100.11	3%
32	100.10	3%
33	100.09	3%
34	100.08	3%
35	100.07	3%
36	100.06	3%
37	100.05	3%
38	100.04	3%
39	100.03	3%
40	100.02	4%
41	100.01	4%
42	100.00	4%
43	99.99	4%
44	99.98	4%
45	99.96	4%
46	99.95	4%
47	99.94	4%
48	99.93	4%
49	99.92	4%
50	99.91	4%
51	99.90	4%
52	99.89	5%
53	99.87	5%
54	99.86	5%
55	99.85	5%
56	99.84	5%
57	99.83	5%
58	99.81	5%
59	99.80	5%
60	99.79	5%
61	99.78	5%
62	99.77	5%
63	99.75	6%
64	99.74	6%
65	99.73	6%
66	99.72	6%
67	99.70	6%
68	99.69	6%
69	99.68	6%
70	99.66	6%
71	99.65	6%
72	99.64	6%
73	99.62	6%
74	99.61	7%
75	99.60	7%
76	99.58	7%
77	99.57	7%
78	99.56	7%
79	99.54	7%
80	99.53	7%
81	99.51	7%
82	99.50	7%
83	99.48	7%
84	99.47	7%
85	99.46	7%
86	99.44	8%
87	99.43	8%
88	99.41	8%
89	99.40	8%
90	99.38	8%
91	99.37	8%
92	99.35	8%
93	99.34	8%
94	99.32	8%
95	99.31	8%
96	99.29	8%
97	99.28	9%
98	99.26	9%
99	99.25	9%
100	99.23	9%
101	99.21	9%
102	99.20	9%
103	99.18	9%
104	99.17	9%
105	99.15	9%
106	99.13	9%
107	99.12	9%
108	99.10	10%
109	99.09	10%
110	99.07	10%
111	99.05	10%
112	99.04	10%
113	99.02	10%
114	99.00	10%
115	98.99	10%
116	98.97	10%
117	98.95	10%
118	98.93	10%
119	98.92	10%
120	98.90	11%
121	98.88	11%
122	98.87	11%
123	98.85	11%

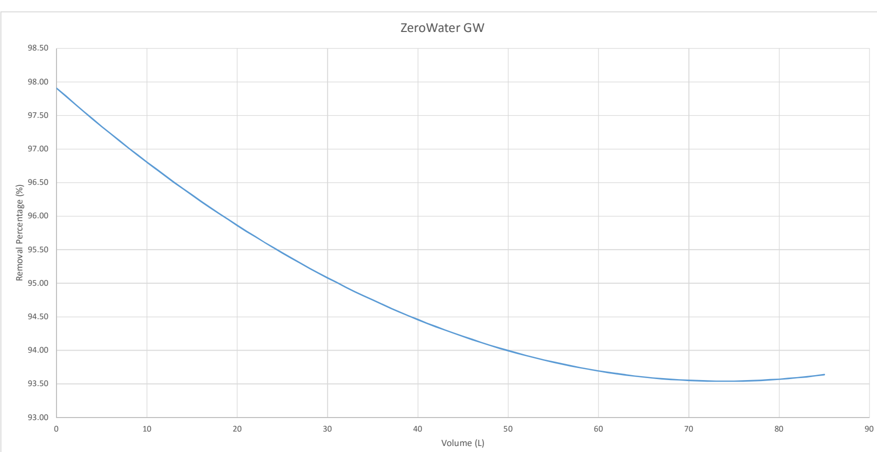
124	59.84	82%	124	50.60	82%
125	59.55	83%	125	50.62	83%
126	59.25	83%	126	50.65	83%
127	58.96	84%	127	50.69	84%
128	58.67	85%	128	50.73	85%
129	58.38	85%	129	50.77	85%
130	58.09	86%	130	50.82	86%
131	57.80	87%	131	50.88	87%
132	57.51	87%	132	50.94	87%
133	57.22	88%	133	51.01	88%
134	56.94	89%	134	51.08	89%
135	56.65	89%	135	51.16	89%
136	56.37	90%	136	51.24	90%
137	56.09	91%	137	51.33	91%
138	55.80	91%	138	51.42	91%
139	55.52	92%	139	51.52	92%
140	55.24	93%	140	51.62	93%
141	54.97	93%	141	51.73	93%
142	54.69	94%	142	51.85	94%
143	54.41	95%	143	51.97	95%
144	54.14	95%	144	52.09	95%
145	53.87	96%	145	52.23	96%
146	53.60	97%	146	52.36	97%
147	53.33	97%	147	52.51	97%
148	53.06	98%	148	52.65	98%
149	52.79	99%	149	52.81	99%
150	52.53	99%	150	52.96	99%
151	52.27	100%	151	53.13	100%



124	97.83	11%	124	98.83	11%
125	97.83	11%	125	98.81	11%
126	97.84	11%	126	98.79	11%
127	97.84	11%	127	98.78	11%
128	97.85	11%	128	98.76	11%
129	97.85	11%	129	98.74	11%
130	97.85	11%	130	98.72	11%
131	97.86	12%	131	98.70	12%
132	97.86	12%	132	98.69	12%
133	97.86	12%	133	98.67	12%
134	97.87	12%	134	98.65	12%
135	97.87	12%	135	98.63	12%
136	97.88	12%	136	98.61	12%
137	97.88	12%	137	98.59	12%
138	97.88	12%	138	98.58	12%
139	97.89	12%	139	98.56	12%
140	97.89	12%	140	98.54	12%
141	97.89	12%	141	98.52	12%
142	97.90	13%	142	98.50	13%
143	97.90	13%	143	98.48	13%
144	97.91	13%	144	98.46	13%
145	97.91	13%	145	98.44	13%
146	97.91	13%	146	98.42	13%
147	97.92	13%	147	98.40	13%
148	97.92	13%	148	98.39	13%
149	97.92	13%	149	98.37	13%
150	97.93	13%	150	98.35	13%
151	97.93	13%	151	98.33	13%
152	97.94	13%	152	98.31	13%
153	97.94	13%	153	98.29	13%
154	97.94	14%	154	98.27	14%
155	97.95	14%	155	98.25	14%
156	97.95	14%	156	98.23	14%
157	97.96	14%	157	98.21	14%
158	97.96	14%	158	98.19	14%
159	97.96	14%	159	98.17	14%
160	97.97	14%	160	98.15	14%
161	97.97	14%	161	98.13	14%
162	97.98	14%	162	98.11	14%
163	97.98	14%	163	98.09	14%
164	97.98	14%	164	98.07	14%
165	97.99	15%	165	98.04	15%
166	97.99	15%	166	98.02	15%
167	98.00	15%	167	98.00	15%
168	98.00	15%	168	97.98	15%
169	98.00	15%	169	97.96	15%
170	98.01	15%	170	97.94	15%
171	98.01	15%	171	97.92	15%
172	98.01	15%	172	97.90	15%
173	98.02	15%	173	97.88	15%
174	98.02	15%	174	97.86	15%
175	98.03	15%	175	97.83	15%
176	98.03	15%	176	97.81	15%
177	98.04	16%	177	97.79	16%
178	98.04	16%	178	97.77	16%
179	98.04	16%	179	97.75	16%
180	98.05	16%	180	97.73	16%
181	98.05	16%	181	97.71	16%
182	98.06	16%	182	97.68	16%
183	98.06	16%	183	97.66	16%
184	98.06	16%	184	97.64	16%
185	98.07	16%	185	97.62	16%
186	98.07	16%	186	97.60	16%
187	98.08	16%	187	97.57	16%
188	98.08	17%	188	97.55	17%
189	98.08	17%	189	97.53	17%
190	98.09	17%	190	97.51	17%
191	98.09	17%	191	97.48	17%
192	98.10	17%	192	97.46	17%
193	98.10	17%	193	97.44	17%
194	98.10	17%	194	97.42	17%
195	98.11	17%	195	97.39	17%
196	98.11	17%	196	97.37	17%
197	98.12	17%	197	97.35	17%
198	98.12	17%	198	97.33	17%
199	98.12	18%	199	97.30	18%
200	98.13	18%	200	97.28	18%
201	98.13	18%	201	97.26	18%
202	98.14	18%	202	97.23	18%
203	98.14	18%	203	97.21	18%
204	98.15	18%	204	97.19	18%
205	98.15	18%	205	97.16	18%
206	98.15	18%	206	97.14	18%
207	98.16	18%	207	97.12	18%
208	98.16	18%	208	97.09	18%
209	98.17	18%	209	97.07	18%
210	98.17	18%	210	97.05	18%
211	98.17	19%	211	97.02	19%
212	98.18	19%	212	97.00	19%
213	98.18	19%	213	96.98	19%
214	98.19	19%	214	96.95	19%
215	98.19	19%	215	96.93	19%
216	98.20	19%	216	96.90	19%
217	98.20	19%	217	96.88	19%
218	98.20	19%	218	96.86	19%
219	98.21	19%	219	96.83	19%
220	98.21	19%	220	96.81	19%
221	98.22	19%	221	96.78	19%
222	98.22	20%	222	96.76	20%
223	98.23	20%	223	96.73	20%
224	98.23	20%	224	96.71	20%
225	98.23	20%	225	96.69	20%
226	98.24	20%	226	96.66	20%
227	98.24	20%	227	96.64	20%
228	98.25	20%	228	96.61	20%
229	98.25	20%	229	96.59	20%
230	98.25	20%	230	96.56	20%
231	98.26	20%	231	96.54	20%
232	98.26	20%	232	96.51	20%
233	98.27	21%	233	96.49	21%
234	98.27	21%	234	96.46	21%
235	98.28	21%	235	96.44	21%
236	98.28	21%	236	96.41	21%
237	98.28	21%	237	96.39	21%
238	98.29	21%	238	96.36	21%
239	98.29	21%	239	96.34	21%
240	98.30	21%	240	96.31	21%
241	98.30	21%	241	96.29	21%
242	98.31	21%	242	96.26	21%
243	98.31	21%	243	96.23	21%
244	98.31	21%	244	96.21	21%
245	98.32	22%	245	96.18	22%
246	98.32	22%	246	96.16	22%
247	98.33	22%	247	96.13	22%
248	98.33	22%	248	96.11	22%
249	98.34	22%	249	96.08	22%

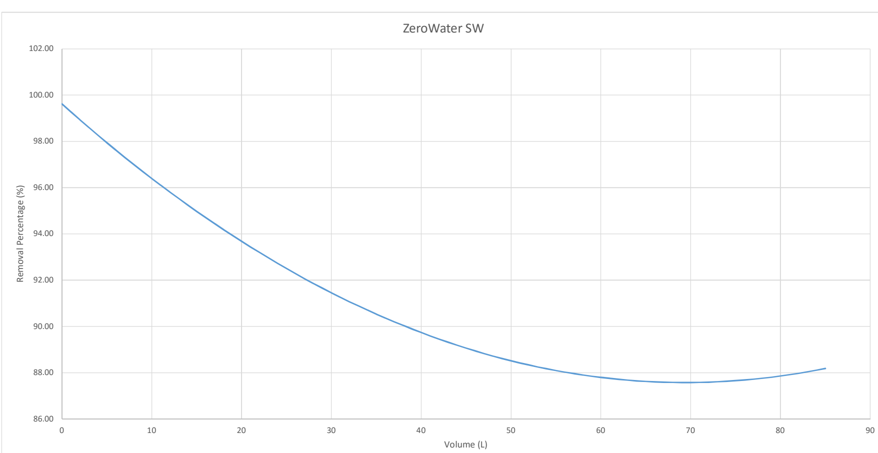
250	98.34	22%	250	96.05	22%
251	98.34	22%	251	96.03	22%
252	98.35	22%	252	96.00	22%
253	98.35	22%	253	95.98	22%
254	98.36	22%	254	95.95	22%
255	98.36	22%	255	95.92	22%
256	98.37	23%	256	95.90	23%
257	98.37	23%	257	95.87	23%
258	98.37	23%	258	95.84	23%
259	98.38	23%	259	95.82	23%
260	98.38	23%	260	95.79	23%
261	98.39	23%	261	95.76	23%
262	98.39	23%	262	95.74	23%
263	98.40	23%	263	95.71	23%
264	98.40	23%	264	95.68	23%
265	98.41	23%	265	95.66	23%
266	98.41	23%	266	95.63	23%
267	98.41	24%	267	95.60	24%
268	98.42	24%	268	95.58	24%
269	98.42	24%	269	95.55	24%
270	98.43	24%	270	95.52	24%
271	98.43	24%	271	95.50	24%
272	98.44	24%	272	95.47	24%
273	98.44	24%	273	95.44	24%
274	98.44	24%	274	95.41	24%
275	98.45	24%	275	95.39	24%
276	98.45	24%	276	95.36	24%
277	98.46	24%	277	95.33	24%
278	98.46	24%	278	95.31	24%
279	98.47	25%	279	95.28	25%
280	98.47	25%	280	95.25	25%
281	98.47	25%	281	95.22	25%
282	98.48	25%	282	95.20	25%
283	98.48	25%	283	95.17	25%
284	98.49	25%	284	95.14	25%
285	98.49	25%	285	95.11	25%
286	98.50	25%	286	95.08	25%
287	98.50	25%	287	95.06	25%
288	98.50	25%	288	95.03	25%
289	98.51	25%	289	95.00	25%
290	98.51	26%	290	94.97	26%
291	98.52	26%	291	94.94	26%
292	98.52	26%	292	94.92	26%
293	98.53	26%	293	94.89	26%
294	98.53	26%	294	94.86	26%
295	98.54	26%	295	94.83	26%
296	98.54	26%	296	94.80	26%
297	98.54	26%	297	94.78	26%
298	98.55	26%	298	94.75	26%
299	98.55	26%	299	94.72	26%
300	98.56	26%	300	94.69	26%
301	98.56	26%	301	94.66	26%
302	98.57	27%	302	94.63	27%
303	98.57	27%	303	94.60	27%
304	98.57	27%	304	94.58	27%
305	98.58	27%	305	94.55	27%
306	98.58	27%	306	94.52	27%
307	98.59	27%	307	94.49	27%
308	98.59	27%	308	94.46	27%
309	98.60	27%	309	94.43	27%
310	98.60	27%	310	94.40	27%
311	98.60	27%	311	94.37	27%
312	98.61	27%	312	94.34	27%
313	98.61	28%	313	94.32	28%
314	98.62	28%	314	94.29	28%
315	98.62	28%	315	94.26	28%
316	98.63	28%	316	94.23	28%
317	98.63	28%	317	94.20	28%
318	98.64	28%	318	94.17	28%
319	98.64	28%	319	94.14	28%
320	98.64	28%	320	94.11	28%
321	98.65	28%	321	94.08	28%
322	98.65	28%	322	94.05	28%
323	98.66	28%	323	94.02	28%
324	98.66	29%	324	93.99	29%
325	98.67	29%	325	93.96	29%
326	98.67	29%	326	93.93	29%
327	98.67	29%	327	93.90	29%
328	98.68	29%	328	93.87	29%
329	98.68	29%	329	93.84	29%
330	98.69	29%	330	93.82	29%
331	98.69	29%	331	93.79	29%
332	98.70	29%	332	93.76	29%
333	98.70	29%	333	93.73	29%
334	98.70	29%	334	93.70	29%
335	98.71	29%	335	93.67	29%
336	98.71	30%	336	93.64	30%
337	98.72	30%	337	93.61	30%
338	98.72	30%	338	93.58	30%
339	98.73	30%	339	93.55	30%
340	98.73	30%	340	93.52	30%
341	98.73	30%	341	93.48	30%
342	98.74	30%	342	93.45	30%
343	98.74	30%	343	93.42	30%
344	98.75	30%	344	93.39	30%
345	98.75	30%	345	93.36	30%
346	98.76	30%	346	93.33	30%
347	98.76	31%	347	93.30	31%
348	98.76	31%	348	93.27	31%
349	98.77	31%	349	93.24	31%
350	98.77	31%	350	93.21	31%
351	98.78	31%	351	93.18	31%
352	98.78	31%	352	93.15	31%
353	98.79	31%	353	93.12	31%
354	98.79	31%	354	93.09	31%
355	98.79	31%	355	93.06	31%
356	98.80	31%	356	93.03	31%
357	98.80	31%	357	93.00	31%
358	98.81	32%	358	92.97	32%
359	98.81	32%	359	92.93	32%
360	98.81	32%	360	92.90	32%
361	98.82	32%	361	92.87	32%
362	98.82	32%	362	92.84	32%
363	98.83	32%	363	92.81	32%
364	98.83	32%	364	92.78	32%
365	98.84	32%	365	92.75	32%
366	98.84	32%	366	92.72	32%
367	98.84	32%	367	92.69	32%
368	98.85	32%	368	92.66	32%
369	98.85	32%	369	92.62	32%
370	98.86	33%	370	92.59	33%
371	98.86	33%	371	92.56	33%
372	98.87	33%	372	92.53	33%
373	98.87	33%	373	92.50	33%
374	98.87	33%	374	92.47	33%
375	98.88	33%	375	92.44	33%

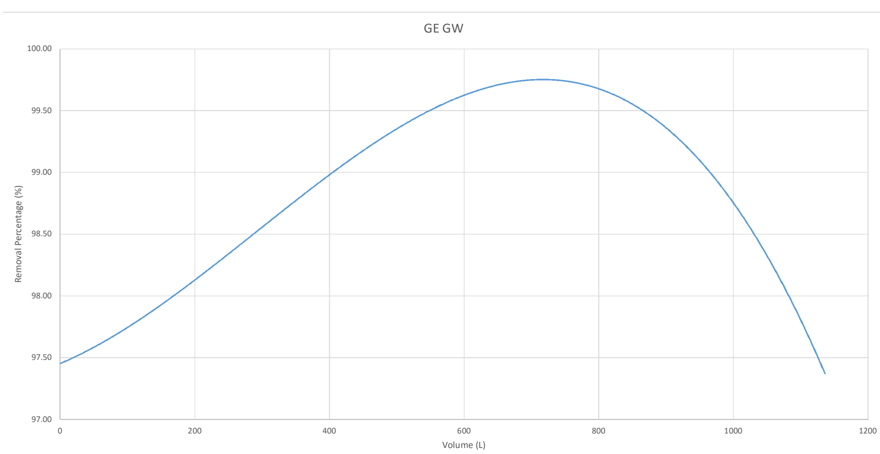




376	98.88	33%	376	92.40	33%
377	98.89	33%	377	92.37	33%
378	98.89	33%	378	92.34	33%
379	98.89	33%	379	92.31	33%
380	98.90	33%	380	92.28	33%
381	98.90	34%	381	92.25	34%
382	98.91	34%	382	92.21	34%
383	98.91	34%	383	92.18	34%
384	98.92	34%	384	92.15	34%
385	98.92	34%	385	92.12	34%
386	98.92	34%	386	92.09	34%
387	98.93	34%	387	92.06	34%
388	98.93	34%	388	92.02	34%
389	98.94	34%	389	91.99	34%
390	98.94	34%	390	91.96	34%
391	98.94	34%	391	91.93	34%
392	98.95	35%	392	91.90	35%
393	98.95	35%	393	91.86	35%
394	98.96	35%	394	91.83	35%
395	98.96	35%	395	91.80	35%
396	98.96	35%	396	91.77	35%
397	98.97	35%	397	91.74	35%
398	98.97	35%	398	91.70	35%
399	98.98	35%	399	91.67	35%
400	98.98	35%	400	91.64	35%
401	98.99	35%	401	91.61	35%
402	98.99	35%	402	91.58	35%
403	98.99	35%	403	91.54	35%
404	99.00	36%	404	91.51	36%
405	99.00	36%	405	91.48	36%
406	99.01	36%	406	91.45	36%
407	99.01	36%	407	91.41	36%
408	99.01	36%	408	91.38	36%
409	99.02	36%	409	91.35	36%
410	99.02	36%	410	91.32	36%
411	99.03	36%	411	91.28	36%
412	99.03	36%	412	91.25	36%
413	99.03	36%	413	91.22	36%
414	99.04	36%	414	91.19	36%
415	99.04	37%	415	91.15	37%
416	99.05	37%	416	91.12	37%
417	99.05	37%	417	91.09	37%
418	99.05	37%	418	91.06	37%
419	99.06	37%	419	91.02	37%
420	99.06	37%	420	90.99	37%
421	99.07	37%	421	90.96	37%
422	99.07	37%	422	90.93	37%
423	99.07	37%	423	90.89	37%
424	99.08	37%	424	90.86	37%
425	99.08	37%	425	90.83	37%
426	99.08	38%	426	90.79	38%
427	99.09	38%	427	90.76	38%
428	99.09	38%	428	90.73	38%
429	99.10	38%	429	90.70	38%
430	99.10	38%	430	90.66	38%
431	99.10	38%	431	90.63	38%
432	99.11	38%	432	90.60	38%
433	99.11	38%	433	90.56	38%
434	99.12	38%	434	90.53	38%
435	99.12	38%	435	90.50	38%
436	99.12	38%	436	90.46	38%
437	99.13	38%	437	90.43	38%
438	99.13	39%	438	90.40	39%
439	99.13	39%	439	90.36	39%
440	99.14	39%	440	90.33	39%
441	99.14	39%	441	90.30	39%
442	99.15	39%	442	90.27	39%
443	99.15	39%	443	90.23	39%
444	99.15	39%	444	90.20	39%
445	99.16	39%	445	90.17	39%
446	99.16	39%	446	90.13	39%
447	99.17	39%	447	90.10	39%
448	99.17	39%	448	90.07	39%
449	99.17	40%	449	90.03	40%
450	99.18	40%	450	90.00	40%
451	99.18	40%	451	89.97	40%
452	99.18	40%	452	89.93	40%
453	99.19	40%	453	89.90	40%
454	99.19	40%	454	89.87	40%
455	99.20	40%	455	89.83	40%
456	99.20	40%	456	89.80	40%
457	99.20	40%	457	89.76	40%
458	99.21	40%	458	89.73	40%
459	99.21	40%	459	89.70	40%
460	99.21	40%	460	89.66	40%
461	99.22	41%	461	89.63	41%
462	99.22	41%	462	89.60	41%
463	99.22	41%	463	89.56	41%
464	99.23	41%	464	89.53	41%
465	99.23	41%	465	89.50	41%
466	99.24	41%	466	89.46	41%
467	99.24	41%	467	89.43	41%
468	99.24	41%	468	89.40	41%
469	99.25	41%	469	89.36	41%
470	99.25	41%	470	89.33	41%
471	99.25	41%	471	89.29	41%
472	99.26	42%	472	89.26	42%
473	99.26	42%	473	89.23	42%
474	99.26	42%	474	89.19	42%
475	99.27	42%	475	89.16	42%
476	99.27	42%	476	89.13	42%
477	99.27	42%	477	89.09	42%
478	99.28	42%	478	89.06	42%
479	99.28	42%	479	89.02	42%
480	99.29	42%	480	88.99	42%
481	99.29	42%	481	88.96	42%
482	99.29	42%	482	88.92	42%
483	99.30	43%	483	88.89	43%
484	99.30	43%	484	88.85	43%
485	99.30	43%	485	88.82	43%
486	99.31	43%	486	88.79	43%
487	99.31	43%	487	88.75	43%
488	99.31	43%	488	88.72	43%
489	99.32	43%	489	88.68	43%
490	99.32	43%	490	88.65	43%
491	99.32	43%	491	88.62	43%
492	99.33	43%	492	88.58	43%
493	99.33	43%	493	88.55	43%
494	99.33	43%	494	88.51	43%
495	99.34	44%	495	88.48	44%
496	99.34	44%	496	88.45	44%
497	99.34	44%	497	88.41	44%
498	99.35	44%	498	88.38	44%
499	99.35	44%	499	88.34	44%
500	99.35	44%	500	88.31	44%
501	99.36	44%	501	88.28	44%

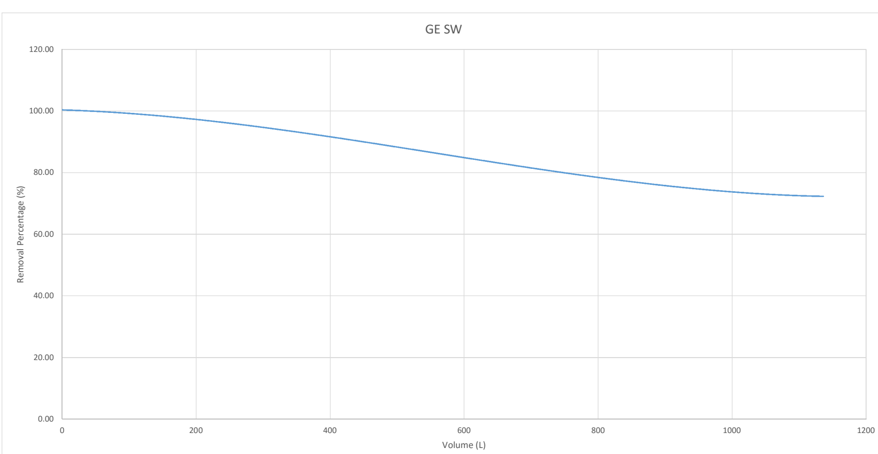
502	99.36	44%	502	88.24	44%
503	99.36	44%	503	88.21	44%
504	99.37	44%	504	88.17	44%
505	99.37	44%	505	88.14	44%
506	99.37	45%	506	88.11	45%
507	99.38	45%	507	88.07	45%
508	99.38	45%	508	88.04	45%
509	99.38	45%	509	88.00	45%
510	99.39	45%	510	87.97	45%
511	99.39	45%	511	87.93	45%
512	99.39	45%	512	87.90	45%
513	99.40	45%	513	87.87	45%
514	99.40	45%	514	87.83	45%
515	99.40	45%	515	87.80	45%
516	99.40	45%	516	87.76	45%
517	99.41	46%	517	87.73	46%
518	99.41	46%	518	87.69	46%
519	99.41	46%	519	87.66	46%
520	99.42	46%	520	87.63	46%
521	99.42	46%	521	87.59	46%
522	99.42	46%	522	87.56	46%
523	99.43	46%	523	87.52	46%
524	99.43	46%	524	87.49	46%
525	99.43	46%	525	87.45	46%
526	99.44	46%	526	87.42	46%
527	99.44	46%	527	87.39	46%
528	99.44	46%	528	87.35	46%
529	99.44	47%	529	87.32	47%
530	99.45	47%	530	87.28	47%
531	99.45	47%	531	87.25	47%
532	99.45	47%	532	87.21	47%
533	99.46	47%	533	87.18	47%
534	99.46	47%	534	87.15	47%
535	99.46	47%	535	87.11	47%
536	99.46	47%	536	87.08	47%
537	99.47	47%	537	87.04	47%
538	99.47	47%	538	87.01	47%
539	99.47	47%	539	86.97	47%
540	99.48	48%	540	86.94	48%
541	99.48	48%	541	86.91	48%
542	99.48	48%	542	86.87	48%
543	99.49	48%	543	86.84	48%
544	99.49	48%	544	86.80	48%
545	99.49	48%	545	86.77	48%
546	99.49	48%	546	86.73	48%
547	99.50	48%	547	86.70	48%
548	99.50	48%	548	86.66	48%
549	99.50	48%	549	86.63	48%
550	99.50	48%	550	86.60	48%
551	99.51	49%	551	86.56	49%
552	99.51	49%	552	86.53	49%
553	99.51	49%	553	86.49	49%
554	99.52	49%	554	86.46	49%
555	99.52	49%	555	86.42	49%
556	99.52	49%	556	86.39	49%
557	99.52	49%	557	86.36	49%
558	99.53	49%	558	86.32	49%
559	99.53	49%	559	86.29	49%
560	99.53	49%	560	86.25	49%
561	99.53	49%	561	86.22	49%
562	99.54	49%	562	86.18	49%
563	99.54	50%	563	86.15	50%
564	99.54	50%	564	86.11	50%
565	99.54	50%	565	86.08	50%
566	99.55	50%	566	86.05	50%
567	99.55	50%	567	86.01	50%
568	99.55	50%	568	85.98	50%
569	99.55	50%	569	85.94	50%
570	99.56	50%	570	85.91	50%
571	99.56	50%	571	85.87	50%
572	99.56	50%	572	85.84	50%
573	99.56	50%	573	85.81	50%
574	99.57	51%	574	85.77	51%
575	99.57	51%	575	85.74	51%
576	99.57	51%	576	85.70	51%
577	99.57	51%	577	85.67	51%
578	99.58	51%	578	85.63	51%
579	99.58	51%	579	85.60	51%
580	99.58	51%	580	85.57	51%
581	99.58	51%	581	85.53	51%
582	99.59	51%	582	85.50	51%
583	99.59	51%	583	85.46	51%
584	99.59	51%	584	85.43	51%
585	99.59	51%	585	85.39	51%
586	99.59	52%	586	85.36	52%
587	99.60	52%	587	85.33	52%
588	99.60	52%	588	85.29	52%
589	99.60	52%	589	85.26	52%
590	99.60	52%	590	85.22	52%
591	99.61	52%	591	85.19	52%
592	99.61	52%	592	85.15	52%
593	99.61	52%	593	85.12	52%
594	99.61	52%	594	85.09	52%
595	99.61	52%	595	85.05	52%
596	99.62	52%	596	85.02	52%
597	99.62	53%	597	84.98	53%
598	99.62	53%	598	84.95	53%
599	99.62	53%	599	84.91	53%
600	99.63	53%	600	84.88	53%
601	99.63	53%	601	84.85	53%
602	99.63	53%	602	84.81	53%
603	99.63	53%	603	84.78	53%
604	99.63	53%	604	84.74	53%
605	99.64	53%	605	84.71	53%
606	99.64	53%	606	84.67	53%
607	99.64	53%	607	84.64	53%
608	99.64	54%	608	84.61	54%
609	99.64	54%	609	84.57	54%
610	99.64	54%	610	84.54	54%
611	99.65	54%	611	84.50	54%
612	99.65	54%	612	84.47	54%
613	99.65	54%	613	84.44	54%
614	99.65	54%	614	84.40	54%
615	99.65	54%	615	84.37	54%
616	99.66	54%	616	84.33	54%
617	99.66	54%	617	84.30	54%
618	99.66	54%	618	84.27	54%
619	99.66	54%	619	84.23	54%
620	99.66	55%	620	84.20	55%
621	99.66	55%	621	84.16	55%
622	99.67	55%	622	84.13	55%
623	99.67	55%	623	84.10	55%
624	99.67	55%	624	84.06	55%
625	99.67	55%	625	84.03	55%
626	99.67	55%	626	83.99	55%
627	99.68	55%	627	83.96	55%





628	99.68	55%	628	83.93	55%
629	99.68	55%	629	83.89	55%
630	99.68	55%	630	83.86	55%
631	99.68	56%	631	83.82	56%
632	99.68	56%	632	83.79	56%
633	99.68	56%	633	83.76	56%
634	99.69	56%	634	83.72	56%
635	99.69	56%	635	83.69	56%
636	99.69	56%	636	83.66	56%
637	99.69	56%	637	83.62	56%
638	99.69	56%	638	83.59	56%
639	99.69	56%	639	83.55	56%
640	99.70	56%	640	83.52	56%
641	99.70	56%	641	83.49	56%
642	99.70	57%	642	83.45	57%
643	99.70	57%	643	83.42	57%
644	99.70	57%	644	83.39	57%
645	99.70	57%	645	83.35	57%
646	99.70	57%	646	83.32	57%
647	99.70	57%	647	83.28	57%
648	99.71	57%	648	83.25	57%
649	99.71	57%	649	83.22	57%
650	99.71	57%	650	83.18	57%
651	99.71	57%	651	83.15	57%
652	99.71	57%	652	83.12	57%
653	99.71	57%	653	83.08	57%
654	99.71	58%	654	83.05	58%
655	99.71	58%	655	83.02	58%
656	99.72	58%	656	82.98	58%
657	99.72	58%	657	82.95	58%
658	99.72	58%	658	82.92	58%
659	99.72	58%	659	82.88	58%
660	99.72	58%	660	82.85	58%
661	99.72	58%	661	82.82	58%
662	99.72	58%	662	82.78	58%
663	99.72	58%	663	82.75	58%
664	99.72	58%	664	82.72	58%
665	99.73	59%	665	82.68	59%
666	99.73	59%	666	82.65	59%
667	99.73	59%	667	82.62	59%
668	99.73	59%	668	82.58	59%
669	99.73	59%	669	82.55	59%
670	99.73	59%	670	82.52	59%
671	99.73	59%	671	82.48	59%
672	99.73	59%	672	82.45	59%
673	99.73	59%	673	82.42	59%
674	99.73	59%	674	82.38	59%
675	99.73	59%	675	82.35	59%
676	99.74	60%	676	82.32	60%
677	99.74	60%	677	82.28	60%
678	99.74	60%	678	82.25	60%
679	99.74	60%	679	82.22	60%
680	99.74	60%	680	82.18	60%
681	99.74	60%	681	82.15	60%
682	99.74	60%	682	82.12	60%
683	99.74	60%	683	82.09	60%
684	99.74	60%	684	82.05	60%
685	99.74	60%	685	82.02	60%
686	99.74	60%	686	81.99	60%
687	99.74	60%	687	81.95	60%
688	99.74	61%	688	81.92	61%
689	99.74	61%	689	81.89	61%
690	99.74	61%	690	81.86	61%
691	99.75	61%	691	81.82	61%
692	99.75	61%	692	81.79	61%
693	99.75	61%	693	81.76	61%
694	99.75	61%	694	81.73	61%
695	99.75	61%	695	81.69	61%
696	99.75	61%	696	81.66	61%
697	99.75	61%	697	81.63	61%
698	99.75	61%	698	81.60	61%
699	99.75	62%	699	81.56	62%
700	99.75	62%	700	81.53	62%
701	99.75	62%	701	81.50	62%
702	99.75	62%	702	81.47	62%
703	99.75	62%	703	81.43	62%
704	99.75	62%	704	81.40	62%
705	99.75	62%	705	81.37	62%
706	99.75	62%	706	81.34	62%
707	99.75	62%	707	81.30	62%
708	99.75	62%	708	81.27	62%
709	99.75	62%	709	81.24	62%
710	99.75	63%	710	81.21	63%
711	99.75	63%	711	81.17	63%
712	99.75	63%	712	81.14	63%
713	99.75	63%	713	81.11	63%
714	99.75	63%	714	81.08	63%
715	99.75	63%	715	81.05	63%
716	99.75	63%	716	81.01	63%
717	99.75	63%	717	80.98	63%
718	99.75	63%	718	80.95	63%
719	99.75	63%	719	80.92	63%
720	99.75	63%	720	80.89	63%
721	99.75	63%	721	80.85	63%
722	99.75	64%	722	80.82	64%
723	99.75	64%	723	80.79	64%
724	99.75	64%	724	80.76	64%
725	99.75	64%	725	80.73	64%
726	99.75	64%	726	80.69	64%
727	99.75	64%	727	80.66	64%
728	99.75	64%	728	80.63	64%
729	99.75	64%	729	80.60	64%
730	99.75	64%	730	80.57	64%
731	99.75	64%	731	80.54	64%
732	99.75	64%	732	80.50	64%
733	99.75	65%	733	80.47	65%
734	99.75	65%	734	80.44	65%
735	99.75	65%	735	80.41	65%
736	99.75	65%	736	80.38	65%
737	99.75	65%	737	80.35	65%
738	99.75	65%	738	80.32	65%
739	99.75	65%	739	80.28	65%
740	99.75	65%	740	80.25	65%
741	99.75	65%	741	80.22	65%
742	99.75	65%	742	80.19	65%
743	99.74	65%	743	80.16	65%
744	99.74	65%	744	80.13	65%
745	99.74	66%	745	80.10	66%
746	99.74	66%	746	80.07	66%
747	99.74	66%	747	80.03	66%
748	99.74	66%	748	80.00	66%
749	99.74	66%	749	79.97	66%
750	99.74	66%	750	79.94	66%
751	99.74	66%	751	79.91	66%
752	99.74	66%	752	79.88	66%
753	99.74	66%	753	79.85	66%

754	99.74	66%	754	79.82	66%
755	99.74	66%	755	79.79	66%
756	99.74	67%	756	79.76	67%
757	99.74	67%	757	79.73	67%
758	99.73	67%	758	79.69	67%
759	99.73	67%	759	79.66	67%
760	99.73	67%	760	79.63	67%
761	99.73	67%	761	79.60	67%
762	99.73	67%	762	79.57	67%
763	99.73	67%	763	79.54	67%
764	99.73	67%	764	79.51	67%
765	99.73	67%	765	79.48	67%
766	99.73	67%	766	79.45	67%
767	99.73	68%	767	79.42	68%
768	99.72	68%	768	79.39	68%
769	99.72	68%	769	79.36	68%
770	99.72	68%	770	79.33	68%
771	99.72	68%	771	79.30	68%
772	99.72	68%	772	79.27	68%
773	99.72	68%	773	79.24	68%
774	99.72	68%	774	79.21	68%
775	99.72	68%	775	79.18	68%
776	99.71	68%	776	79.15	68%
777	99.71	68%	777	79.12	68%
778	99.71	68%	778	79.09	68%
779	99.71	69%	779	79.06	69%
780	99.71	69%	780	79.03	69%
781	99.71	69%	781	79.00	69%
782	99.71	69%	782	78.97	69%
783	99.71	69%	783	78.94	69%
784	99.70	69%	784	78.91	69%
785	99.70	69%	785	78.88	69%
786	99.70	69%	786	78.85	69%
787	99.70	69%	787	78.82	69%
788	99.70	69%	788	78.79	69%
789	99.70	69%	789	78.76	69%
790	99.69	70%	790	78.73	70%
791	99.69	70%	791	78.70	70%
792	99.69	70%	792	78.67	70%
793	99.69	70%	793	78.64	70%
794	99.69	70%	794	78.61	70%
795	99.69	70%	795	78.59	70%
796	99.68	70%	796	78.56	70%
797	99.68	70%	797	78.53	70%
798	99.68	70%	798	78.50	70%
799	99.68	70%	799	78.47	70%
800	99.68	70%	800	78.44	70%
801	99.68	71%	801	78.41	71%
802	99.67	71%	802	78.38	71%
803	99.67	71%	803	78.35	71%
804	99.67	71%	804	78.32	71%
805	99.67	71%	805	78.30	71%
806	99.67	71%	806	78.27	71%
807	99.66	71%	807	78.24	71%
808	99.66	71%	808	78.21	71%
809	99.66	71%	809	78.18	71%
810	99.66	71%	810	78.15	71%
811	99.66	71%	811	78.12	71%
812	99.65	71%	812	78.10	71%
813	99.65	72%	813	78.07	72%
814	99.65	72%	814	78.04	72%
815	99.65	72%	815	78.01	72%
816	99.64	72%	816	77.98	72%
817	99.64	72%	817	77.95	72%
818	99.64	72%	818	77.93	72%
819	99.64	72%	819	77.90	72%
820	99.63	72%	820	77.87	72%
821	99.63	72%	821	77.84	72%
822	99.63	72%	822	77.81	72%
823	99.63	72%	823	77.79	72%
824	99.63	73%	824	77.76	73%
825	99.62	73%	825	77.73	73%
826	99.62	73%	826	77.70	73%
827	99.62	73%	827	77.67	73%
828	99.62	73%	828	77.65	73%
829	99.61	73%	829	77.62	73%
830	99.61	73%	830	77.59	73%
831	99.61	73%	831	77.56	73%
832	99.60	73%	832	77.54	73%
833	99.60	73%	833	77.51	73%
834	99.60	73%	834	77.48	73%
835	99.60	74%	835	77.45	74%
836	99.59	74%	836	77.43	74%
837	99.59	74%	837	77.40	74%
838	99.59	74%	838	77.37	74%
839	99.59	74%	839	77.34	74%
840	99.58	74%	840	77.32	74%
841	99.58	74%	841	77.29	74%
842	99.58	74%	842	77.26	74%
843	99.57	74%	843	77.24	74%
844	99.57	74%	844	77.21	74%
845	99.57	74%	845	77.18	74%
846	99.56	74%	846	77.16	74%
847	99.56	75%	847	77.13	75%
848	99.56	75%	848	77.10	75%
849	99.56	75%	849	77.08	75%
850	99.55	75%	850	77.05	75%
851	99.55	75%	851	77.02	75%
852	99.55	75%	852	77.00	75%
853	99.54	75%	853	76.97	75%
854	99.54	75%	854	76.94	75%
855	99.54	75%	855	76.92	75%
856	99.53	75%	856	76.89	75%
857	99.53	75%	857	76.86	75%
858	99.53	76%	858	76.84	76%
859	99.52	76%	859	76.81	76%
860	99.52	76%	860	76.79	76%
861	99.52	76%	861	76.76	76%
862	99.51	76%	862	76.73	76%
863	99.51	76%	863	76.71	76%
864	99.51	76%	864	76.68	76%
865	99.50	76%	865	76.66	76%
866	99.50	76%	866	76.63	76%
867	99.50	76%	867	76.60	76%
868	99.49	76%	868	76.58	76%
869	99.49	76%	869	76.55	76%
870	99.48	77%	870	76.53	77%
871	99.48	77%	871	76.50	77%
872	99.48	77%	872	76.48	77%
873	99.47	77%	873	76.45	77%
874	99.47	77%	874	76.43	77%
875	99.47	77%	875	76.40	77%
876	99.46	77%	876	76.38	77%
877	99.46	77%	877	76.35	77%
878	99.45	77%	878	76.33	77%
879	99.45	77%	879	76.30	77%



880	99.45	77%	880	76.28	77%
881	99.44	78%	881	76.25	78%
882	99.44	78%	882	76.23	78%
883	99.43	78%	883	76.20	78%
884	99.43	78%	884	76.18	78%
885	99.43	78%	885	76.15	78%
886	99.42	78%	886	76.13	78%
887	99.42	78%	887	76.10	78%
888	99.41	78%	888	76.08	78%
889	99.41	78%	889	76.05	78%
890	99.40	78%	890	76.03	78%
891	99.40	78%	891	76.01	78%
892	99.40	79%	892	75.98	79%
893	99.39	79%	893	75.96	79%
894	99.39	79%	894	75.93	79%
895	99.38	79%	895	75.91	79%
896	99.38	79%	896	75.89	79%
897	99.37	79%	897	75.86	79%
898	99.37	79%	898	75.84	79%
899	99.37	79%	899	75.81	79%
900	99.36	79%	900	75.79	79%
901	99.36	79%	901	75.77	79%
902	99.35	79%	902	75.74	79%
903	99.35	79%	903	75.72	79%
904	99.34	80%	904	75.70	80%
905	99.34	80%	905	75.67	80%
906	99.33	80%	906	75.65	80%
907	99.33	80%	907	75.63	80%
908	99.32	80%	908	75.60	80%
909	99.32	80%	909	75.58	80%
910	99.31	80%	910	75.56	80%
911	99.31	80%	911	75.53	80%
912	99.30	80%	912	75.51	80%
913	99.30	80%	913	75.49	80%
914	99.29	80%	914	75.46	80%
915	99.29	81%	915	75.44	81%
916	99.28	81%	916	75.42	81%
917	99.28	81%	917	75.40	81%
918	99.27	81%	918	75.37	81%
919	99.27	81%	919	75.35	81%
920	99.26	81%	920	75.33	81%
921	99.26	81%	921	75.31	81%
922	99.25	81%	922	75.28	81%
923	99.25	81%	923	75.26	81%
924	99.24	81%	924	75.24	81%
925	99.24	81%	925	75.22	81%
926	99.23	82%	926	75.20	82%
927	99.23	82%	927	75.17	82%
928	99.22	82%	928	75.15	82%
929	99.22	82%	929	75.13	82%
930	99.21	82%	930	75.11	82%
931	99.21	82%	931	75.09	82%
932	99.20	82%	932	75.06	82%
933	99.19	82%	933	75.04	82%
934	99.19	82%	934	75.02	82%
935	99.18	82%	935	75.00	82%
936	99.18	82%	936	74.98	82%
937	99.17	82%	937	74.96	82%
938	99.17	83%	938	74.94	83%
939	99.16	83%	939	74.91	83%
940	99.16	83%	940	74.89	83%
941	99.15	83%	941	74.87	83%
942	99.14	83%	942	74.85	83%
943	99.14	83%	943	74.83	83%
944	99.13	83%	944	74.81	83%
945	99.13	83%	945	74.79	83%
946	99.12	83%	946	74.77	83%
947	99.11	83%	947	74.75	83%
948	99.11	83%	948	74.73	83%
949	99.10	84%	949	74.71	84%
950	99.10	84%	950	74.69	84%
951	99.09	84%	951	74.67	84%
952	99.08	84%	952	74.65	84%
953	99.08	84%	953	74.63	84%
954	99.07	84%	954	74.61	84%
955	99.07	84%	955	74.59	84%
956	99.06	84%	956	74.57	84%
957	99.05	84%	957	74.55	84%
958	99.05	84%	958	74.53	84%
959	99.04	84%	959	74.51	84%
960	99.03	85%	960	74.49	85%
961	99.03	85%	961	74.47	85%
962	99.02	85%	962	74.45	85%
963	99.02	85%	963	74.43	85%
964	99.01	85%	964	74.41	85%
965	99.00	85%	965	74.39	85%
966	99.00	85%	966	74.37	85%
967	98.99	85%	967	74.35	85%
968	98.98	85%	968	74.33	85%
969	98.98	85%	969	74.31	85%
970	98.97	85%	970	74.29	85%
971	98.96	85%	971	74.27	85%
972	98.96	86%	972	74.26	86%
973	98.95	86%	973	74.24	86%
974	98.94	86%	974	74.22	86%
975	98.94	86%	975	74.20	86%
976	98.93	86%	976	74.18	86%
977	98.92	86%	977	74.16	86%
978	98.91	86%	978	74.14	86%
979	98.91	86%	979	74.13	86%
980	98.90	86%	980	74.11	86%
981	98.89	86%	981	74.09	86%
982	98.89	86%	982	74.07	86%
983	98.88	87%	983	74.05	87%
984	98.87	87%	984	74.04	87%
985	98.86	87%	985	74.02	87%
986	98.86	87%	986	74.00	87%
987	98.85	87%	987	73.98	87%
988	98.84	87%	988	73.96	87%
989	98.84	87%	989	73.95	87%
990	98.83	87%	990	73.93	87%
991	98.82	87%	991	73.91	87%
992	98.81	87%	992	73.90	87%
993	98.81	87%	993	73.88	87%
994	98.80	88%	994	73.86	88%
995	98.79	88%	995	73.84	88%
996	98.78	88%	996	73.83	88%
997	98.78	88%	997	73.81	88%
998	98.77	88%	998	73.79	88%
999	98.76	88%	999	73.78	88%
1000	98.75	88%	1000	73.76	88%
1001	98.75	88%	1001	73.74	88%
1002	98.74	88%	1002	73.73	88%
1003	98.73	88%	1003	73.71	88%
1004	98.72	88%	1004	73.69	88%
1005	98.71	88%	1005	73.68	88%

1006	98.71	89%	1006	73.66	89%
1007	98.70	89%	1007	73.65	89%
1008	98.69	89%	1008	73.63	89%
1009	98.68	89%	1009	73.61	89%
1010	98.67	89%	1010	73.60	89%
1011	98.67	89%	1011	73.58	89%
1012	98.66	89%	1012	73.57	89%
1013	98.65	89%	1013	73.55	89%
1014	98.64	89%	1014	73.54	89%
1015	98.63	89%	1015	73.52	89%
1016	98.63	89%	1016	73.50	89%
1017	98.62	90%	1017	73.49	90%
1018	98.61	90%	1018	73.47	90%
1019	98.60	90%	1019	73.46	90%
1020	98.59	90%	1020	73.44	90%
1021	98.58	90%	1021	73.43	90%
1022	98.58	90%	1022	73.41	90%
1023	98.57	90%	1023	73.40	90%
1024	98.56	90%	1024	73.39	90%
1025	98.55	90%	1025	73.37	90%
1026	98.54	90%	1026	73.36	90%
1027	98.53	90%	1027	73.34	90%
1028	98.52	90%	1028	73.33	90%
1029	98.52	91%	1029	73.31	91%
1030	98.51	91%	1030	73.30	91%
1031	98.50	91%	1031	73.28	91%
1032	98.49	91%	1032	73.27	91%
1033	98.48	91%	1033	73.26	91%
1034	98.47	91%	1034	73.24	91%
1035	98.46	91%	1035	73.23	91%
1036	98.45	91%	1036	73.22	91%
1037	98.44	91%	1037	73.20	91%
1038	98.44	91%	1038	73.19	91%
1039	98.43	91%	1039	73.18	91%
1040	98.42	92%	1040	73.16	92%
1041	98.41	92%	1041	73.15	92%
1042	98.40	92%	1042	73.14	92%
1043	98.39	92%	1043	73.12	92%
1044	98.38	92%	1044	73.11	92%
1045	98.37	92%	1045	73.10	92%
1046	98.36	92%	1046	73.08	92%
1047	98.35	92%	1047	73.07	92%
1048	98.34	92%	1048	73.06	92%
1049	98.33	92%	1049	73.05	92%
1050	98.32	92%	1050	73.03	92%
1051	98.32	93%	1051	73.02	93%
1052	98.31	93%	1052	73.01	93%
1053	98.30	93%	1053	73.00	93%
1054	98.29	93%	1054	72.98	93%
1055	98.28	93%	1055	72.97	93%
1056	98.27	93%	1056	72.96	93%
1057	98.26	93%	1057	72.95	93%
1058	98.25	93%	1058	72.94	93%
1059	98.24	93%	1059	72.93	93%
1060	98.23	93%	1060	72.91	93%
1061	98.22	93%	1061	72.90	93%
1062	98.21	93%	1062	72.89	93%
1063	98.20	94%	1063	72.88	94%
1064	98.19	94%	1064	72.87	94%
1065	98.18	94%	1065	72.86	94%
1066	98.17	94%	1066	72.85	94%
1067	98.16	94%	1067	72.84	94%
1068	98.15	94%	1068	72.83	94%
1069	98.14	94%	1069	72.81	94%
1070	98.13	94%	1070	72.80	94%
1071	98.12	94%	1071	72.79	94%
1072	98.11	94%	1072	72.78	94%
1073	98.10	94%	1073	72.77	94%
1074	98.09	95%	1074	72.76	95%
1075	98.08	95%	1075	72.75	95%
1076	98.07	95%	1076	72.74	95%
1077	98.06	95%	1077	72.73	95%
1078	98.05	95%	1078	72.72	95%
1079	98.03	95%	1079	72.71	95%
1080	98.02	95%	1080	72.70	95%
1081	98.01	95%	1081	72.69	95%
1082	98.00	95%	1082	72.68	95%
1083	97.99	95%	1083	72.67	95%
1084	97.98	95%	1084	72.67	95%
1085	97.97	96%	1085	72.66	96%
1086	97.96	96%	1086	72.65	96%
1087	97.95	96%	1087	72.64	96%
1088	97.94	96%	1088	72.63	96%
1089	97.93	96%	1089	72.62	96%
1090	97.92	96%	1090	72.61	96%
1091	97.91	96%	1091	72.60	96%
1092	97.89	96%	1092	72.59	96%
1093	97.88	96%	1093	72.59	96%
1094	97.87	96%	1094	72.58	96%
1095	97.86	96%	1095	72.57	96%
1096	97.85	96%	1096	72.56	96%
1097	97.84	97%	1097	72.55	97%
1098	97.83	97%	1098	72.55	97%
1099	97.82	97%	1099	72.54	97%
1100	97.81	97%	1100	72.53	97%
1101	97.79	97%	1101	72.52	97%
1102	97.78	97%	1102	72.51	97%
1103	97.77	97%	1103	72.51	97%
1104	97.76	97%	1104	72.50	97%
1105	97.75	97%	1105	72.49	97%
1106	97.74	97%	1106	72.49	97%
1107	97.72	97%	1107	72.48	97%
1108	97.71	98%	1108	72.47	98%
1109	97.70	98%	1109	72.46	98%
1110	97.69	98%	1110	72.46	98%
1111	97.68	98%	1111	72.45	98%
1112	97.67	98%	1112	72.44	98%
1113	97.65	98%	1113	72.44	98%
1114	97.64	98%	1114	72.43	98%
1115	97.63	98%	1115	72.43	98%
1116	97.62	98%	1116	72.42	98%
1117	97.61	98%	1117	72.41	98%
1118	97.59	98%	1118	72.41	98%
1119	97.58	99%	1119	72.40	99%
1120	97.57	99%	1120	72.40	99%
1121	97.56	99%	1121	72.39	99%
1122	97.55	99%	1122	72.38	99%
1123	97.53	99%	1123	72.38	99%
1124	97.52	99%	1124	72.37	99%
1125	97.51	99%	1125	72.37	99%
1126	97.50	99%	1126	72.36	99%
1127	97.48	99%	1127	72.36	99%
1128	97.47	99%	1128	72.35	99%
1129	97.46	99%	1129	72.35	99%
1130	97.45	99%	1130	72.34	99%
1131	97.43	100%	1131	72.34	100%

1132	97.42	100%	1132	72.33	100%
1133	97.41	100%	1133	72.33	100%
1134	97.40	100%	1134	72.33	100%
1135	97.38	100%	1135	72.32	100%
1136	97.37	100%	1136	72.32	100%